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(54) Title: A PROCESS FOR PRODUCING POLYPEPTIDES WITH REDUCED ALLERGENICITY

(57) Abstract

The invention relates to a process for producing polypeptides with reduced allergenicity, by a) fermenting a microorganism capable of producing said polypeptide, b) recovering said polypeptide in substantially pure form, wherein said microorganism is modified in a manner whereby the expressed polypeptide molecules self-oligomerize. Further contemplated are a DNA construct comprising genes encoding such polypeptides, a recombinant expression vector or transformation vehicle comprising said DNA construct, a cell harbouring said DNA construct or vector. Further microbially produced polypeptides with reduced allergenicity produced according to the process of the invention and compositions comprising said polypeptides. Finally the invention relates to the use of Zipper domains for reducing allergenicity of polypeptides.

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Title: A process for producing polypeptides with reduced allergenicity

FIELD OF THE INVENTION

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The invention relates to a process for producing polypeptides with reduced allergenicity. Further to a DNA construct comprising genes encoding such polypeptides, a recombinant expression vector or transformation vehicle comprising said DNA construct, 10 a cell harbouring said DNA construct or vector. Also contemplated is polypeptides with reduced allergenicity produced according to the process of the invention, oligomeric polypeptides with reduced allergenicity, and compositions comprising said polypeptides. Finally the invention relates to the use of 15 Zipper domains for reducing the allergenicity of polypeptides.

BACKGROUND OF THE INVENTION

20 An increasing number of polypeptides, including enzymes and non-enzymatic proteins, are being produced industrially for use in industry, household, food/feed, cosmetics, medicine etc. Being polypeptides they are capable of stimulating the immune systems of animals and humans.

25

Allergenicity of polypeptides

Generally, most humans are not exposed to polypeptides to a degree that will generate adverse effects, but certain risk groups exist for which these phenomena are of significant 30 importance.

These risk groups include employees handling the manufacturing products comprising enzymes and professions such as hair-dressers which are daily in direct contact with products 35 comprising polypeptides.

For such risk groups certain polypeptides can elicit the production of different kinds of antibodies and/or give a cellular

response. At least one of these routes can give adverse effects in humans and animals, as exposure to polypeptides may result in sensitisation and subsequently allergy.

5 While sensitisation is defined as an immune status, allergy is characterized as a clinical disease. Allergy in general requires two or more encounters with antigens. The first exposure lead to a primary immune response which results in sensitisation of the individual. If the sensitised individual comes in
10 contact with the same antigen again it may provoke an allergic response.

More specifically, IgE (or comparable molecules) attach to specific receptors on the surface of mast cells, which contain
15 many large cytoplasmic granules packed with chemical mediators. Once attached to a mast cell, the IgE molecule can survive for many weeks with its antibody reaction site, available to interact with a specific allergen.

20 Individuals having IgE-mediated allergy have many IgE antibodies fixed to mast cells. Upon exposure the specific allergen molecules readily combines with the cell-fixed corresponding IgE antibodies. This leads to cellular release of the cytoplasmic granules of chemical mediators, which gives symptoms like
25 rhinitis, conjunctivitis, uricaria or other allergic reactions.

Such allergic responses occur within minutes or a few hours after exposure to an allergen, and are often referred to as "immediate hypersensitivity reactions".

30

IgE-mediated hypersensitivity reaction may occur when the allergen is introduced via the respiratory tract by inhalation.

The occurrence of allergic responses is believed at least
35 partly to depend on the way of exposure. For instance, it have been found that intranasal challenge with allergenic proteins provokes an allergic response even though skin tests and radioallergosorbent test (RAST) for specific serum IgE are

negative (Ivan Roitt, "Essential Immunology", fifth edition, p. 152 and p. 240, 1984).

5 Reduction of allergenicity of polypeptides

In general prior art methods for reducing the allergenicity of polypeptides consist of various ways of immobilizing, granulating, coating or dissolving the polypeptides to avoid especially polypeptides in dust form from stimulating the immune system.

10

There will anyhow still be a risk of having polypeptide dust or dissolved polypeptide in aerosol form. Therefore some release of polypeptides can occur leading to a possible sensitisation and subsequent allergic response.

15

Another way of diminishing the problem has been to select polypeptides of human origin for production, e.g. in bacteria or mammalian cell cultures. This may alleviate some problems for humans, but not for animals. Furthermore, it will in many cases not be possible to find polypeptides of human origin with the desired properties, for which reason other origin has to be considered. This can be either human polypeptides that are altered in one or more positions in the molecule, giving performance that is desired. It might also be molecules from other species, including bacteria, mold etc. All the latter groups of products will have potency for immune stimulation.

A further proposition for decreasing allergenicity has been to reduce the size of the polypeptide molecules (see e.g. JP Patent Publication No. 4112753, or Research Disclosure No. 335102). This is, however, a solution that is only available when the activity of the polypeptide is without importance, or in such rare cases, where the activity of the polypeptide in question is retained in spite of a breakdown of the polypeptide.

The use of protein engineering has been suggested to reduce the allergenicity of polypeptides through epitope mapping and sub-

sequent change of the allergenic epitopes (see WO 92/10755 (Novo Nordisk A/S)).

In the medicinal field suggestions have been made of diminishing the antigenicity or immunogenicity of polypeptides through the attachment of one or more polymeric molecules to the polypeptide. This usually has the effect of interfering with the interactions of the polypeptide with other macromolecular structures.

10

Such a conjugate may also exhibit novel properties: e.g. EP 38 154 (Beecham Group Ltd.) discloses conjugates of allergens with polysarcosine which have immunosuppressive properties.

15 US patent no. 4,179,337 (Enzon) concerns non-immunogenic polypeptides, such as enzymes and peptide hormones coupled to polyethylene glycol (PEG) or polypropylene glycol. Between 10 and 100 moles of polymer are used per mole polypeptide and at least 15% of the physiological activity is maintained. The protected
20 polypeptide is injected in an aqueous solution either into the mammalian circulatory system or intramuscularly. The non-immunogenicity is assessed from intradermal injection tests.

It has been found that the attachment of one or more polymeric
25 molecules to a polypeptide molecule in general has the effect of reducing the activity of e.g. the enzyme or interfering with the interaction between the enzyme and its substrate.

EP 183 503 (Beecham Group PLC) discloses a development of the
30 above concept by providing conjugates comprising pharmaceutically useful polypeptides linked to at least one water-soluble polymer by means of a reversible linking group.

EP 471 125 (Kanebo, LTD.) describes a modified protease linked
35 to a polysaccharide via a triazine ring leading to a suppressing effect on antigenicity and dermal hypersensitivity. The employed polysaccharide has an average molecular weight not less than 10,000. The modification rate for surface amino acid

groups in the modified protease is not less than 30%.

In general it is believed that allergens, entering the respiratory tract, must have a molecular weight lower than about 100 kDa in order to penetrate the plasma membrane and cause allergic reactions.

WO 94/10191 (Novo Nordisk A/S) discloses a process for production of low allergenic protein, wherein the monomeric parent protein molecules are linked together to form an oligomer. This is done e.g. by using a linker or spacer molecule or by linking the monomeric molecules together by peptide bonds between the C-terminal of the first monomer and the N-terminal of the second monomer.

15

Folkesson et al., Acta Physiol. Scand, 139, p. 437-354, 1990, showed that there is an inverse relationship between the molecular weight of an instilled protein marker and the transferred amount (bioavailability) via the respiratory tract to the blood stream.

EP 215 662 (Masda, Hiroshi) concerns a modified or unmodified protease derived from microorganisms for use in medicaments such as anti-tumour agent. The modification of the protease may be carried out by forming dimers or oligomers by cross-linking the protease molecules.

Enlargement of polypeptides by the use of Zipper domains

As can be seen from the above different techniques of enlarging polypeptides have been known for some time.

"Zipper technique"

Another technique which may be referred to as "Zipper technique" is known to cause oligomerization of polypeptides.

Zipper technique makes it possible to link polypeptide molecules to each other by means of self-oligomerizing polypeptide

domains (in the following referred to as Zipper domains). Examples of such Zipper domains include the well-known α -helical bundles, crossed bundles, multiple bundles, parallel coiled coils, poly(L-glutamine) strands.

5

The simplest cases of Zipper domains include the helical bundles which consist of amphiphilic helices, e.g. Leucine Zippers and four α -helical bundles. These domains share a characteristic seven-amino acid repeat of the type
10 (a,b,c,d,e,f,g),. Positions "a" and "d" of the heptad repeat are generally hydrophobic, a property which signals the potential for the interlocking of α -helices, as suggested by Crick (Acta crystallogr., 6, p. 689-697, 1953).

15 Despite the common pattern different sequences form two-, three, four-stranded and even higher order stranded helical bundles (Cohen et. al., TIBS, 11, 245-248, 1986; Cohen, Proteins, vol. 7, p. 1-15, 1990; Cohen, Science 263, p. 488-489, 1994; O'Shea et al., Cell, 68, p. 699-708, 1992; O'Shea et
20 al., Science, 254, p. 539-545, 1991; O'Shea et al. Science, 243, p. 538-542, 1989; Eisenberg et al., Proteins, 1, p.16-22, 1986; Ho et al., J. Am. Chem. Soc, 109, p. 6751-6758, 1987).

An example of a Leucine Zipper is the 33 amino acid sequence
25 located at the C-terminus of GCN4, a yeast transcription factor, which belongs to a class of DNA binding polypeptides (O'Shea et al. Science, 243, p. 538-542, 1989).

Through genetic engineering the specific GCN4 Leucine Zipper
30 has been fused to different polypeptides and shown to mediate dimerization of monomeric polypeptides.

Hu et al., Science, Vol. 250, p. 1400-1403, 1990, describes a genetic system where a GCN4 Leucine Zipper is fused to the N-
35 terminal domain of bacteriophage λ repressor and used as a reporter for dimerization.

Blondel and Bedouelle (Protein Engineering, 4, p. 457-461,

1991) dimerized a maltose binding protein (MalE) in *E. coli*.

In general Leucine Zippers form homo-dimers, but within the group of Leucine Zippers there are specific motifs which favour the formation of hetero-dimers. Two examples of such are the Fos and Jun Leucine Zipper (O'Shea et al. Science, 245, p. 646, 1989; Turner and Tjian, Science, 243 p. 1689, 1989) and the artificially made hetero dimeric coiled coil described by O'Shea (Current Biology, vol. 3, no 10, p. 658-667, 1993).

10

Also the above mentioned self-oligomerizing four α -helical bundles have been shown to dimerize with a murine ScFv antibody fragment expressed in *E. coli*. The antibody fragment is fused to polypeptide motifs (see figure 7) of two identical helices from antiparallel four helical bundle designed by Eisenberg et al., supra, 1986 and Ho et al., supra, 1987, in which the two helices are separated by a turn. The four helix bundle was formed from two molecules each contributing two helices (Pack et al. Bio/Technology, vol. 11, p. 1271-1277, 1993).

20

Concerning Zipper domains resulting in higher order oligomerization, Lovejoy et al., Science, 259, p. 1288, 1993, reported the synthesis of a triple stranded α -helix bundle in which the helices run up-up-down. This construct was made by introducing specific mutations in the otherwise dimerized GCN4 Leucine Zipper.

Incorporation of glutamine repeats (poly(L-glutamine) also makes proteins oligomerize to form polar Zippers (Stott et al., (1995), Proceedings of the National Academy of Sciences of the United States of America 92 (14), p. 6509-6513.

Another polypeptide motif which can mediate trimerization is the naturally occurring motif of the shock transcription factor of *Saccharomyces cerevisiae* and *Kluveromyces lactis* described by Peteranderl et al, Biochemistry, 31, p. 12272-12276, 1992.

Examples of tetrameric formation involves altering amino ac

residues in the GCN4 Leucine Zipper (Harbury et al., Science, 262, p. 1401-1407, 1993. This was only shown for small peptides.

- 5 An oligomerization motif from myosin fused to recombinant protein can mediate the formation of higher order polypeptide oligomers (Wolber et al., BIO/TECHNOLOGY, 10, p. 900-904, 1992). The expressed fusion polypeptide forms oligomers at low salt concentration and dissociates at high salt concentrations.
- 10

Discussion of prior art

All the previously described methods for reducing the allergenicity of polypeptides involve at least one additional
15 production step in comparison to the production of the corresponding parent polypeptides. This makes the processes cumbersome and raises the cost of producing polypeptides with reduced allergenicity.

- 20 Prior art only describes Zipper domains as means for oligomerizing polypeptides.

It would be desirable to be able to reduce the allergenicity of polypeptides by increasing the size of the polypeptides as an
25 integrated part of the polypeptide production process.

SUMMARY OF THE INVENTION

- 30 It is the object of the invention to provide an integrated industrial applicable process for producing polypeptides with reduced allergenicity.

The present inventors have perceived the potential of using
35 Zipper domains for industrial uses, and have now surprisingly accomplished to provide a process for producing a polypeptide with reduced allergenicity, by

- a) fermenting a microorganism capable of producing said

polypeptide, and

b) recovering said polypeptide in substantially pure form, wherein said microorganism is modified in a manner whereby the expressed polypeptide molecules self-oligomerize.

5

In an embodiment of the invention said microorganism has been modified by the introduction of one or more DNA constructs comprising a DNA sequence coding for at least one polypeptide and at least one Zipper domain.

10

Another object of the invention is to provide a DNA construct for the production of polypeptides with reduced allergenicity, comprising a DNA sequence encoding at least one polypeptide molecule with at least one Zipper domain.

15

The invention also relates to a recombinant vector or transformation vehicle, comprising said DNA construct of the invention, and furthermore to a cell comprising said DNA construct or said recombinant vector or transformation vehicle.

20

Further, the invention is directed towards microbially polypeptides with reduced allergenicity produced according to the process of the invention. Also contemplated are compositions comprising at least one polypeptide component of the
25 invention.

Finally the invention relates to the use of Zipper domains for reducing the allergenicity of polypeptides.

30

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows the DNA sequence and derived amino acid sequence of a linker, the GCN4 Leucine Zipper and a flexible C-terminal
35 extension peptide containing a cystein amino acid residue.

Figure 2 shows the construction steps of the pAZ-1 plasmid

Figure 3 shows a coomassie blue stained SDS-PAGE run under non-reducing conditions, wherein lane 4 is a molecular weight marker SeeBlue™ (Cat.:#LC5625, Novex, Inc., Ca, USA), and lanes 2 and 3 are polypeptides expressed by *E. coli* JM105 comprising the DNA construct pAZ-1.

Figure 4 shows coomassie blue stained SDS-PAGE run under reducing conditions, wherein lane 1 is a molecular weight marker SeeBlue™ (Cat.:#LC5625, Novex, Inc., Ca, USA), and lanes 2 and 3 are polypeptides expressed by *E. coli* JM105 comprising the DNA construct pAZ-1.

Figure 5 shows a Western blot. Lane 1 is the molecular weight marker. Lanes 2 and 3 are samples from the induced JM105/pAZ-1 run under non-reduced conditions. Lanes 4 and 5 are the same samples run under reduced conditions.

Figure 6 shows the number of Dunkin Hartley guinea pig, having been exposed to 1.0 µg monomer and 1.0 µg dimer Termamyl® intratracheally, found to be IgG₁ positive vs. days starting from the day of exposure.

DETAILED DESCRIPTION OF THE INVENTION

25

The present inventors have now surprisingly succeeded in providing an integrated industrially applicable process for producing polypeptides with reduced allergenicity, wherein the biological activity of the polypeptides is at least substantially maintained.

A "substantially" maintained activity is in the context of the present invention defined as an activity which is at least between 20% and 30%, preferably between 30% and 40%, more preferably between 40% and 60%, better from 60% up to 80%, even better from 80% up to about 100%, in comparison to the activity of the not modified parent polypeptide.

Said polypeptides may be used for a vast number of industrial applications which will be exemplified below.

It is to be understood that, in connection with industrial applications of polypeptides, it is mainly inhalation of the allergens that may inflict a risk of an allergic response. Therefore, one of the crucial advantages of the present invention is, that the inventors have solved the problem of respiratory challenge with allergens, whereas prior art solutions mainly concern dermal challenge with alleged immunogens. Respiratory challenge is a much more sensitive question.

The term "reduced allergenicity" indicates that the amount of produced IgE (in humans, and molecules with comparable effects in specific animals, for instance IgG₁ in guinea pigs), which can lead to an allergic state are significantly decreased when inhaling a polypeptide of the invention in comparison to the corresponding parent polypeptide.

The terms "immunogen", "antigen" and "allergen" are defined below, as these term often are use in an unclear manner, even by scientists.

An "immunogen" may be defined as a substance which when introduced into humans and animals is capable of stimulating an immunologic response.

The term "antigen" refers to substances which by themselves are capable of generating antibodies when recognized as a non-self molecule by the immune system.

Further, an "allergen" may be defined as an antigen which may give rise to allergic sensitization or an allergic response by IgE antibodies (in humans, and molecules with comparable effects in animals).

It is to be understood that the term "immunogen" is the wider term and includes "antigen" and "allergen".

As mentioned above it is, at least in the context of polypeptides of the present invention, important to distinguish between dermal allergens mediating allergic responses caused by skin contact, and respiratory allergens causing allergic responses by contact with cell-bound IgE in the bronchial tree, due to the well-known fact that skin tests may be negative even though inhalation tests provoke an allergic response.

Therefore assessment of allergenicity may be made by inhalation tests, comparing the effect of intratracheal administered parent polypeptides with the corresponding polypeptides of the invention with reduced allergenicity.

Two main hazard assessment approaches exists, animal models and in vitro models, respectively. Animal models recommended by ECETOC (see Monografi ECETOC no. 19, p. 17-27) includes both mice and guinea pig models.

The mice models focus upon events occurring during the induction phase of sensitisation following primary encounter of the substance in question. However, mice are not considered suitable for investigating polypeptides.

In contrast hereto the guinea pig models seek to identify respiratory allergens as a function of elicitation reactions induced in previously sensitised animals. ECETOC assesses results of studies using guinea pig as a suitable basis for hazard assessment in man.

Specifically, in the context of assessment of allergenicity of polypeptides according to the invention, models involving introduction of polypeptides intratracheal in guinea pigs are suitable.

One suitable strain of guinea pigs, the Dunkin Hartley strain, does not (as humans) produce IgE antibodies in connection with the allergic response. However, they produce another type of antibody the IgG₁A and IgG₁B which characterize their allergenic

response to inhaled polypeptides (see e.g. Prentø, ATLA, 19, p. 8-14, 1991).

Therefore when using the Dunkin Hartley animal model, the relative amounts of IgG_A and IgG_B are a measure for the allergenicity level.

Other animal models such as rats, rabbits etc. could also be used for comparable studies.

10

The production of a polypeptide with reduced allergenicity according to the invention specifically comprises

a) fermenting a microorganism capable of producing said polypeptide, and

15 b) recovering said polypeptide in substantially pure form, wherein said microorganism is modified in a manner whereby the expressed polypeptide molecules self-oligomerize.

The allergenicity of the polypeptides is believed to be reduced
20 by the enlargement of the polypeptides.

The term "self-oligomerization" does in the context of the present invention mean joining together a desired number of polypeptide molecules, e.g. by the use of Zipper domains, and
25 includes dimerization, trimerization, tetramerization, multimerization, polymerization etc.

In a preferred embodiment of the invention the microorganism is modified by introducing one or more DNA construct(s) into said
30 microorganism. Said DNA construct comprises a DNA sequence encoding at least one polypeptide of interest operably linked to at least one Zipper domain. Optionally the DNA sequence may further comprise a short linker sequence between the sequence encoding the polypeptide and the Zipper domain and/or a DNA
35 sequence encoding a purification tag.

The recovery of the oligomerized polypeptide may be carried out in any suitable way. In the case of using a poly-His tail

purification tag the polypeptides may be recovered by IMAC (Immobilized Metal Affinity Chromatography) following the procedure described in e.g. Yip et al., (1994), Molecular Biotechnology, vol. 1, p. 151-164; Fatiadi et al., (1987), CRC
5 Critical Rev. Anal. Chem. 18, p. 1-44.

A linker sequence is a DNA sequence encoding an amino acid sequence connecting the polypeptide in question and the Zipper domain.

10

The enlargement of the polypeptides takes place during fermentation. The amino acid sequence of the Zipper domain is expressed grafted to the N- or C-terminal of the polypeptide of interest. When this fusion-polypeptide is expressed Zipper
15 domains associate e.g. two and two and are held together by hydrophobic and electrostatic interactions.

Dependent on the Zipper domain used the fusion polypeptide may also form trimers, tetramers etc.

20

The process of the invention is advantageous due to the fact that no additional step need to be executed after the fermentation and before the recovery to obtain the polypeptide product with reduced allergenicity.

25

Further, it is also an advantage that the process according to the invention may be used for any polypeptides of interest, which may be any polypeptides that in parent form may cause an allergic reaction.

30

This group comprises polypeptides having a molecular weight below about 100 kDa. In general the said molecular weight lies in the range of between about 5 kDa and 150 kDa, preferably from between about 20 kDa and 100 kDa, especially from between
35 about 20 kDa and 80 kDa.

The polypeptides may be of microbial or mammalian origin and may be naturally occurring polypeptides or variants thereof.

In an embodiment of the invention the polypeptide of interest is an enzyme exhibiting at least one catalytic activity.

Such enzymes may be selected from the group comprising proteases (metallo, acid, neutral or alkaline), lipases, cutinases, cellulases, amylases, lyases, xylanases, pectinases, pullulanase, polygalacturonases, oxidases, laccases, oxidoreductases, transglutaminases, α -galactocidases, phytases and peroxidases

10 A specific example of such enzyme is Termamyl® (Novo Nordisk A/S), an α -amylase, having a molecular weight of about 55 kDa. The process of the invention enables the production of hybrid products exhibiting more than one biological activity, e.g. hetero-dimeric enzymes which exhibit two different catalytic
15 activities, such as lipolytic and proteolytic activities.

Also contemplated are trimeric, tetrameric, multimeric polypeptides and/or enzymes exhibiting one or more catalytic activities.

20

The polypeptide with reduced allergenicity may be produced by any suitable bacteria or fungal organisms as described below.

DNA construct

25 Another object of the invention is to provide a DNA construct for the production of polypeptides with reduced allergenicity, comprising a DNA sequence encoding at least one polypeptide, and at least one Zipper domain.

30 As used herein the term "DNA construct" is intended to indicate any nucleic acid molecule of cDNA, genomic DNA, synthetic DNA, RNA or PNA origin. The term "construct" is intended to indicate a nucleic acid segment which may be single- or double-stranded, and which may be based on a DNA sequence encoding a polypeptide
35 of interest fused to at least one Zipper domain. The construct may optionally contain other DNA segments, such as a short linker sequence and/or a sequence encoding a peptide segment specifically used for purification purposes.

The DNA construct of the invention may suitably be of genomic or cDNA origin, for instance obtained by preparing a genomic or cDNA library and screening for DNA sequences coding for all or parts of the polypeptide of interest by hybridization using synthetic oligonucleotide probes in accordance with standard techniques (cf. Sambrook et al., Molecular Cloning. A Laboratory Manual, Cold Spring Harbor, NY, 1989).

The DNA sequence may encode a polypeptide exhibiting catalytic activities. In particular, the DNA sequence may encoding at least one enzyme selected from the group comprising proteases (metallo, acid, neutral or alkaline), lipases, cutinases, cellulases, amylases, lyases, xylanases, pectinases, polygalacturonases, oxidases, laccases, oxidoreductases, transglutaminases, α -galactosidases, phytases or peroxidases.

The DNA construct of the invention may also be prepared synthetically by established standard methods, e.g. the phosphoramidite method described by Beaucage and Caruthers, Tetrahedron Letters, 22, p. 1859 - 1869, 1981, or the method described by Matthes et al., EMBO Journal, 3, p. 801 - 805, 1984. According to the phosphoramidite method, oligonucleotides are synthesized, e.g. in an automatic DNA synthesizer, purified, annealed, ligated and cloned in suitable vectors.

25

Furthermore, the DNA construct may be of mixed synthetic and genomic, mixed synthetic and cDNA or mixed genomic and cDNA origin prepared by ligating fragments of synthetic, genomic or cDNA origin (as appropriate), the fragments corresponding to various parts of the entire DNA construct, in accordance with standard techniques.

The DNA construct may also be prepared by polymerase chain reaction using specific primers, for instance as described in US 4,683,202 or Saiki et al., Science, 239, p. 487 - 491, 1988.

In a specific embodiment the DNA construct of the invention comprises the DNA sequence shown in SEQ ID NO 1 as well as

nucleic acid sequences encoding the amino acid sequence shown in SEQ ID NO 2, but may differ from the DNA sequence shown in SEQ ID NO 1 by virtue of the degeneracy of the genetic code.

5 Recombinant vector

In a further aspect the present invention relates to a recombinant vector or transformation vehicle comprising a DNA construct of the invention. The recombinant vector into which the DNA construct of the invention is inserted may be any vector
10 which may conveniently be subjected to recombinant DNA procedures, and the choice of vector will often depend on the host cell into which it is to be introduced. Thus, the vector may be an autonomously replicating vector, i.e. a vector which exists as an extrachromosomal entity, the replication of which is in-
15 dependent of chromosomal replication, e.g. a plasmid. Alternatively, the vector may be one which, when introduced into a host cell, is integrated into the host cell genome and replicated together with the chromosome(s) into which it has been integrated.

20

The vector is preferably an expression vector in which the DNA sequence encoding the polypeptide of interest to be self-oligomerized is operably linked to additional segments required for transcription of the DNA. In general, the expression vector is
25 derived from plasmid or viral DNA, or may contain elements of both. The term, "operably linked" indicates that the segments are arranged so that they function in concert for their intended purposes, e.g. transcription initiates in a promoter and proceeds through the DNA sequence coding for the polypeptide of
30 interest.

The promoter may be any DNA sequence which shows transcriptional activity in the host cell of choice and may be derived from genes encoding polypeptides either homologous or
35 heterologous to the host cell.

Examples of suitable promoters for use in yeast host cells include promoters from yeast glycolytic genes (Hitzeman et al.,

J. Biol. Chem., 255, p. 12073 - 12080, 1980; Alber and Kawasaki, J. Mol. Appl. Gen., 1, p. 419 - 434, 1982) or alcohol dehydrogenase genes (Young et al., in Genetic Engineering of Microorganisms for Chemicals (Hollaender et al, eds.), Plenum Press, New York, 1982), or the TPI1 (US 4,599,311) or ADH2-4c (Russell et al., Nature, 304, p. 652 - 654, 1983) promoters.

Examples of suitable promoters for use in filamentous fungus host cells are, for instance, the ADH3 promoter (McKnight et al., The EMBO J., 4, p. 2093 - 2099, 1985) or the *tpiA* promoter. Examples of other useful promoters are those derived from the gene encoding *A. oryzae* TAKA amylase, *Rhizomucor miehei* aspartic proteinase, *A. niger* neutral α -amylase, *A. niger* acid stable α -amylase, *A. niger* or *A. awamori* glucoamylase (*gluA*), *Rhizomucor miehei* lipase, *A. oryzae* alkaline protease, *A. oryzae* triose phosphate isomerase or *A. nidulans* acetamidase. Preferred are the TAKA-amylase and *gluA* promoters.

Examples of suitable promoters for use in bacterial host cells include the promoter of the *Bacillus stearothermophilus* maltogenic amylase gene, the *Bacillus licheniformis* alpha-amylase gene, the *Bacillus amyloliquefaciens* BAN amylase gene, the *Bacillus subtilis* alkaline protease gen, or the *Bacillus pumilus* xylosidase gene, or by the phage Lambda P_R or P_L promoters or the *E. coli* lac, trp or tac promoters.

The DNA sequence may also, if necessary, be operably connected to a suitable terminator.

The recombinant vector of the invention may further comprise a DNA sequence enabling the vector to replicate in the host cell in question..

The vector may also comprise a selectable marker, e.g. a gene the product of which complements a defect in the host cell, such as the gene coding for dihydrofolate reductase (DHFR) or the *Schizosaccharomyces pombe* TPI gene (described by P.R. Russell, Gene 40, 1985, p. 125-130), or one which confers

resistance to a drug, e.g. ampicillin, kanamycin, tetracyclin, phleomycin, chloramphenicol, neomycin, hygromycin or methotrexate. For filamentous fungi, selectable markers include *amdS*, *pyrG*, *argB*, *niaD*, *trpC* and *sc*.

5

To direct the polypeptide into the secretory pathway of the host cells, a secretory signal sequence (also known as a leader sequence, prepro sequence or pre sequence) may be provided in the recombinant vector. The secretory signal sequence is joined
10 to the DNA sequence encoding the polypeptide in the correct reading frame. Secretory signal sequences are commonly positioned 5' to the DNA sequence encoding the polypeptide. The secretory signal sequence may be that normally associated with the polypeptide or may be from a gene encoding another secreted
15 polypeptide.

For secretion from yeast cells, the secretory signal sequence may encode any signal peptide which ensures efficient direction of the expressed polypeptide into the secretory pathway of the
20 cell. The signal peptide may be naturally occurring signal peptide, or a functional part thereof, or it may be a synthetic peptide. Suitable signal peptides have been found to be the α -factor signal peptide (cf. US 4,870,008), the signal peptide of mouse salivary amylase (cf. O. Hagenbuchle et al., *Nature*, 289,
25 p. 643-646, 1981), a modified carboxypeptidase signal peptide (cf. L.A. Valls et al., *Cell*, 48, p. 887-897, 1987), the yeast *BAR1* signal peptide (cf. WO 87/02670), or the yeast aspartic protease 3 (*YAP3*) signal peptide (cf. M. Egel-Mitani et al., *Yeast*, 6, p. 127-137, 1990).

30

For efficient secretion in yeast, a sequence encoding a leader peptide may also be inserted downstream of the signal sequence and upstream of the DNA sequence encoding the polypeptide. The function of the leader peptide is to allow the expressed
35 polypeptide to be directed from the endoplasmic reticulum to the Golgi apparatus and further to a secretory vesicle for secretion into the culture medium (i.e. exportation of the polypeptide across the cell wall or at least through the

cellular membrane into the periplasmic space of the yeast cell). The leader peptide may be the yeast α -factor leader (the use of which is described in e.g. US 4,546,082, EP 16 201, EP 123 294, EP 123 544 and EP 163 529). Alternatively, the leader peptide may be a synthetic leader peptide, which is to say a leader peptide not found in nature. Synthetic leader peptides may, for instance, be constructed as described in WO 89/02463 or WO 92/11378.

- 10 For use in filamentous fungi, the signal peptide may conveniently be derived from a gene encoding an *Aspergillus* sp. amylase or glucoamylase, a gene encoding a *Rhizomucor miehei* lipase or protease or a *Humicola lanuginosa* lipase.
- 15 The signal peptide is preferably derived from a gene encoding *A. oryzae* TAKA amylase, *A. niger* neutral α -amylase, *A. niger* acid-stable amylase, or *A. niger* glucoamylase.

In a preferred specific embodiment of the invention said vector
20 is the pAZ-1 expression vector.

The procedures used to ligate the DNA sequences coding for the polypeptide in question, the promoter and optionally the terminator and/or secretory signal sequence, respectively, and to
25 insert them into suitable vectors containing the information necessary for replication, are well known to persons skilled in the art (cf., for instance, Sambrook et al., supra, 1989).

Host cell

- 30 The DNA sequence encoding the fusion polypeptide in question, introduced into the host cell may be either homologous or heterologous to the host in question. If homologous to the host cell, i.e. produced by the host cell in nature, it will typically be operably connected to another promoter sequence
35 or, if applicable, another secretory signal sequence and/or terminator sequence than in its natural environment. The term "homologous" is intended to include a cDNA sequence encoding a polypeptide native to the host organism in question. The term

"heterologous" is intended to include a DNA sequence not expressed by the host cell in nature. Thus, the DNA sequence may be from another organism, or it may be a synthetic sequence.

- 5 The host cell into which the DNA construct or the recombinant vector of the invention is introduced may be any cell which is capable of producing the polypeptide of interest and includes bacteria, yeast, filamentous fungi.
- 10 Examples of bacterial host cells which, on cultivation, are capable of producing the polypeptide of interest are grampositive bacteria such as strains of *Bacillus*, such as strains of *B. subtilis*, *B. licheniformis*, *B. lentus*, *B. brevis*, *B. stearothermophilus*, *B. alkalophilus*, *B. amyloliquefaciens*, *B.*
15 *coagulans*, *B. circulans*, *B. lautus*, *B. megaterium* or *B. thuringiensis*, or strains of *Streptomyces*, such as *S. lividans*, *S. murinus* or *S. griseus*, or gramnegative bacteria such as *Escherichia coli*. The transformation of the bacteria may be effected by protoplast transformation or by using competent cells in a
20 manner known per se (cf. Sambrook et al., supra).

When expressing the polypeptide in bacteria such as *E. coli*, the polypeptide may be retained in the cytoplasm, typically as insoluble granules (known as inclusion bodies), or may be directed to the periplasmic space by a bacterial secretion sequence. In the former case, the cells are lysed and the granules are recovered and denatured after which the polypeptide is refolded by diluting the denaturing agent. In the latter case, the polypeptide may be recovered from the periplasmic space by disrupting the cells, e.g. by sonication or osmotic shock, to release the contents of the periplasmic space and recovering the polypeptide.

Examples of suitable yeasts cells include cells of *Saccharomyces* spp. or *Schizosaccharomyces* spp., in particular strains of *Saccharomyces cerevisiae* or *Saccharomyces kluyveri*. Methods for transforming yeast cells with heterologous DNA and producing heterologous polypeptide therefrom are described, e.g. in US

4,599,311, US 4,931,373, US 4,870,008, 5,037,743, and US 4,845,075, all of which are hereby incorporated by reference. Transformed cells are selected by a phenotype determined by a selectable marker, commonly drug resistance or the ability to grow in the absence of a particular nutrient, e.g. leucine. A preferred vector for use in yeast is the POT1 vector disclosed in US 4,931,373. The DNA sequence encoding the polypeptide of the invention may be preceded by a signal sequence and optionally a leader sequence, e.g. as described above. Further examples of suitable yeast cells are strains of *Kluyveromyces*, such as *K. lactis*, *Hansenula*, e.g. *H. polymorpha*, or *Pichia*, e.g. *P. pastoris* (cf. Gleeson et al., J. Gen. Microbiol. 132, 1986, p. 3459-3465; US 4,882,279).

Examples of other fungal cells are cells of filamentous fungi, e.g. *Aspergillus* spp., *Neurospora* spp., *Fusarium* spp. or *Trichoderma* spp., in particular strains of *A. oryzae*, *A. nidulans* or *A. niger*. The use of *Aspergillus* spp. for the expression of polypeptides is described in, e.g., EP 272 277, EP 238 023 and EP 184 438. The transformation of *F. oxysporum* may, for instance, be carried out as described by Malardier et al., Gene, 78, p. 147-156, 1989.

When a filamentous fungus is used as the host cell it may be transformed with the DNA construct of the invention conveniently by integrating the DNA construct in the host chromosome to obtain a recombinant host cell. This integration is generally considered to be an advantage as the DNA sequence is more likely to be stably maintained in the cell. Integration of the DNA constructs into the host chromosome may be performed according to conventional methods, e.g. by homologous or heterologous recombination.

The transformed host cell described above is then cultured in a suitable nutrient medium under conditions permitting the expression of the polypeptide of interest, after which the resulting polypeptide is recovered from the culture.

The medium used to culture the cells may be any conventional medium suitable for growing the host cells, such as minimal or complex media containing appropriate supplements. Suitable media are available from commercial suppliers or may be prepared according to published recipes (e.g. in catalogues of the American Type Culture Collection). The polypeptide produced by the cells may then be recovered from the culture medium by conventional procedures including separating the host cells from the medium by centrifugation or filtration, precipitating the proteinaceous components of the supernatant or filtrate by means of a salt, e.g. ammonium sulphate, purification by a variety of chromatographic procedures, e.g. ion exchange chromatography, gelfiltration chromatography, affinity chromatography, or the like, dependent on the type of polypeptide in question.

Polypeptides

The invention is also directed towards polypeptides with reduced allergenicity produced according to a process of the invention.

The polypeptide of the invention consist of a Zipper domain fused to the polypeptide of interest. The N- or C-terminal of the amino acid sequence of the polypeptide is grafted to the Zipper domain.

The Zipper domain may be any domain capable of oligomerizing the polypeptides in the production phase. In a specific embodiment the Zipper domain is a Leucine Zipper, such as the GCN4 Leucine Zipper.

Preferably the monomeric polypeptide has a molecular weight of between 5 kDa and 150 kDa, preferable between 20 kDa and 100 kDa, especially between 20 kDa and 80 kDa.

35

When using Leucine Zippers for oligomerizing polypeptides consisting of two polypeptide molecules, such as two Termamyl® molecules, the Leucine Zippers normally have enough affinity to

keep the homo-dimer stable. However, to further stabilize the dimer, a cysteine may be included in the Leucine Zipper. This construction can lead to the formation of a disulfide bridge between the two monomers of hybrid polypeptide.

5

The polypeptide of the invention comprises from 2 to 10 polypeptide molecules or more. In a preferred embodiment the self-oligomerized polypeptide is a dimer, a trimer, a tetramer, or an oligomer.

10

It is possible to persist or resume the biological activity of the polypeptide, e.g. the enzymatic activity of a dimerized enzyme.

15 Further the polypeptide of the invention may exhibit more than one biological activity, e.g. two or more different enzymatic activities, such as lipolytic and proteolytic activities.

Oligomeric polypeptides

20 The invention also related to oligomeric polypeptides with reduced allergenicity comprising at least one polypeptide bonded or linked to at least one Zipper domain which is coupled to at least one polypeptide bonded or linked to at least one Zipper domain.

25

Said oligomeric polypeptides may be homo-oligomeric, hetero-oligomeric or higher order oligomeric polypeptide produced by any suitable process or prepared by any suitable method.

30 Said Zipper domain may be any of the previously mentioned Zipper domains.

In an embodiment said oligomeric polypeptide exhibits at least one of the previously mentioned enzymatic activities.

35

Said Zipper domain may be linked to either the C- or N-terminal of the polypeptide(s) in question.

In the following the term "polypeptide" includes both polypeptides produced according to the process of the invention and said oligomeric polypeptides of the invention.

5 A polypeptide according to the invention may demonstrate a high degree of controlled stability.

In certain cases the polypeptides may advantageously be irreversible fused together, which entails that the product has
10 only negligible tendency to disintegrate, which would lead to the return of conditions that may cause an allergenic state.

However in certain other cases, it is advantageous that the polypeptides stay oligomerized in the production and/or bulk
15 handling phase, but dissociates later on, when the polypeptides does not inflict a risk of exposure to humans or animals.

The cleavage of the linkage between the polypeptides may be activated e.g. by physical conditions, such as pH, ionic
20 strength, temperature, reduction or oxidation potential etc.

Further the presence of specific compounds may result in dissociating e.g. into lower order oligomers or monomers.

25 Especially in the case where the activity of the polypeptides are reduced in the oligomerized form, dissociation may be advantageous.

Composition

30 The invention also relates to a composition comprising at least one polypeptide and/or at least one oligomeric polypeptide of the invention.

The composition may further comprise other ingredients normally
35 used in e.g. detergents, including soap bars, household articles, agrochemicals, personal care products, cosmetics, toiletry, pharmaceuticals, composition used for treating food and/or feed etc.

Detergent compositions

According to the invention, a polypeptide of the invention may be an enzyme used in detergent compositions. It may be included in the detergent composition in the form of a non-dusting granulate, a stabilized liquid, or a protected enzyme. Non-dusting granulates may be produced, e.g., as disclosed in US 4,106,991 and 4,661,452 (both to Novo Industri A/S) and may optionally be coated by methods known in the art. Examples of waxy coating materials are poly(ethylene oxide) products (polyethyleneglycol, PEG) with mean molecular weights of 1000 to 20000; ethoxylated nonylphenols having from 16 to 50 ethylene oxide units; ethoxylated fatty alcohols in which the alcohol contains from 12 to 20 carbon atoms and in which there are 15 to 80 ethylene oxide units; fatty alcohols; fatty acids; and mono- and di- and triglycerides of fatty acids. Examples of film-forming coating materials suitable for application by fluid bed techniques are given in patent GB 1483591. Liquid enzyme preparations may, for instance, be stabilized by adding a polyol such as propylene glycol, a sugar or sugar alcohol, lactic acid or boric acid according to established methods. Other enzyme stabilizers are well known in the art. Protected enzymes may be prepared according to the method disclosed in EP 238,216.

- 25 The detergent composition may be in any convenient form, e.g. as powder, granules, paste or liquid. A liquid detergent may be aqueous, typically containing up to 70% water and 0-30% organic solvent, or nonaqueous.
- 30 The detergent composition comprises one or more surfactants, each of which may be anionic, nonionic, cationic, or zwitterionic. The detergent will usually contain 0-50% of anionic surfactant such as linear alkylbenzenesulfonate (LAS), alpha-olefinsulfonate (AOS), alkyl sulfate (fatty alcohol sulfate) (AS), alcohol ethoxysulfate (AEOS or AES), secondary alkanesulfonates (SAS), alpha-sulfo fatty acid methyl esters, alkyl- or alkenylsuccinic acid, or soap. It may also contain 0-40% of nonionic surfactant such as alcohol ethoxylate (AEO or AE),

carboxylated alcohol ethoxylates, nonylphenol ethoxylate, alkylpolyglycoside, alkyltrimethylamine oxide, ethoxylated fatty acid monoethanolamide, fatty acid monoethanolamide, or polyhydroxy alkyl fatty acid amide (e.g. as described in WO 5 92/06154).

The detergent composition may additionally comprise one or more enzymes, such as e.g. amylases, lipases, cutinases, proteases, cellulases, peroxidases, and oxidases.

10

The detergent may contain 1-65% of a detergent builder or complexing agent such as zeolite, diphosphate, triphosphate, phosphonate, citrate, nitrilotriacetic acid (NTA), ethylenediaminetetraacetic acid (EDTA), diethylenetriaminepentaacetic acid (DTMPA), alkyl- or alkenylsuccinic acid, soluble silicates or layered silicates (e.g. SKS-6 from Hoechst). The detergent may also be unbuilt, i.e. essentially free of detergent builder.

20 The detergent may comprise one or more polymers. Examples are carboxymethylcellulose (CMC), poly(vinylpyrrolidone) (PVP), polyethyleneglycol (PEG), poly(vinyl alcohol) (PVA), polycarboxylates such as polyacrylates, maleic/acrylic acid copolymers and lauryl methacrylate/acrylic acid copolymers.

25

The detergent may contain a bleaching system which may comprise a H_2O_2 source such as perborate or percarbonate which may be combined with a peracid-forming bleach activator such as tetraacetythylenediamine (TAED) or nonanoyloxybenzenesulfonate (NOBS). Alternatively, the bleaching system may comprise peroxyacids of, e.g., the amide, imide, or sulfone type.

The detergent composition of the invention comprising the polypeptide of the invention may be stabilized using conventional stabilizing agents, e.g. a polyol such as propylene glycol or glycerol, a sugar or sugar alcohol, lactic acid, boric acid, or a boric acid derivative such as, e.g., an aromatic borate ester, and the composition may be formulated as

described in, e.g., WO 92/19709 and WO 92/19708.

The detergent may also contain other conventional detergent ingredients such as, e.g., fabric conditioners including clays, 5 foam boosters, suds suppressors, anti-corrosion agents, soil-suspending agents, anti-soil-redeposition agents, dyes, bactericides, optical brighteners, or perfume.

The pH (measured in aqueous solution at use concentration) will 10 usually be neutral or alkaline, e.g. in the range of 7-11.

Particular forms of detergent compositions within the scope of the invention include:

- 15 1) A detergent composition formulated as a granulate having a bulk density of at least 600 g/l comprising
 - linear alkylbenzenesulfonate (calculated as acid) 7 - 12%
 - 20 - alcohol ethoxysulfate (e.g. C₁₂₋₁₈ alcohol, 1-2 EO) or alkyl sulfate (e.g. C₁₆₋₁₈) 1 - 4%
 - alcohol ethoxylate (e.g. C₁₄₋₁₅ alcohol, 7 EO) 5 - 9%
 - 25 - sodium carbonate (as Na₂CO₃) 14 - 20%
 - soluble silicate (as Na₂O, 2SiO₂) 2 - 6%
 - 30 - zeolite (as NaAlSiO₄) 15 - 22%
 - sodium sulfate (as Na₂SO₄) 0 - 6%
 - 35 - sodium citrate/citric acid (as C₆H₅Na₃O₇/C₆H₈O₇) 0 - 15%
 - sodium perborate (as NaBO₃·H₂O) 11 - 18%
 - TAED 2 - 6%
 - 40 - carboxymethylcellulose 0 - 2%
 - polymers (e.g. maleic/acrylic acid copolymer, PVP, PEG) 0 - 3%
 - 45 - enzymes 0 - 5%
 - minor ingredients (e.g. suds

- suppressors, perfume, optical brightener, photobleach) 0 - 5%
- 5 2) A detergent composition formulated as a granulate having a bulk density of at least 600 g/l comprising
- linear alkylbenzenesulfonate (calculated as acid) 6 - 11%
 - 10 - alcohol ethoxysulfate (e.g. C₁₂₋₁₈ alcohol, 1-2 EO) or alkyl sulfate (e.g. C₁₆₋₁₈) 1 - 3%
 - alcohol ethoxylate (e.g. C₁₄₋₁₅ alcohol, 7 EO) 5 - 9%
 - 15 - sodium carbonate (as Na₂CO₃) 15 - 21%
 - soluble silicate (as Na₂O, 2SiO₂) 1 - 4%
 - 20 - zeolite (as NaAlSiO₄) 24 - 34%
 - sodium sulfate (as Na₂SO₄) 4 - 10%
 - 25 - sodium citrate/citric acid (as C₆H₅Na₃O₇/C₆H₈O₇) 0 - 15%
 - carboxymethylcellulose 0 - 2%
 - polymers (e.g. maleic/acrylic acid copolymer, PVP, PEG) 1 - 6%
 - 30 - enzymes 0 - 5%
 - minor ingredients 0 - 5%
 - 35 (e.g. suds suppressors, perfume)
- 3) A detergent composition formulated as a granulate having a bulk density of at least 600 g/l comprising
- 40 - linear alkylbenzenesulfonate (calculated as acid) 5 - 9%
 - alcohol ethoxylate (e.g. C₁₂₋₁₅ alcohol, 7 EO) 7 - 14%
 - 45 - soap as fatty acid (e.g. C₁₆₋₂₂ fatty acid) 1 - 3%
 - sodium carbonate (as Na₂CO₃) 10 - 17%
 - 50 - soluble silicate (as Na₂O, 2SiO₂) 3 - 9%
 - zeolite (as NaAlSiO₄) 23 - 33%

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| | - sodium sulfate (as Na_2SO_4) | 0 - 4% |
| | - sodium perborate (as $\text{NaBO}_3 \cdot \text{H}_2\text{O}$) | 8 - 16% |
| 5 | - TAED | 2 - 8% |
| | - phosphonate (e.g. EDTMPA) | 0 - 1% |
| | - carboxymethylcellulose | 0 - 2% |
| 10 | - polymers (e.g. maleic/acrylic acid copolymer, PVP, PEG) | 0 - 3% |
| | - enzymes | 0 - 5% |
| 15 | - minor ingredients (e.g. suds suppressors, perfume, optical brightener) | 0 - 5% |

20 4) A detergent composition formulated as a granulate having a bulk density of at least 600 g/l comprising

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| | - linear alkylbenzenesulfonate (calculated as acid) | 8 - 12% |
| 25 | - alcohol ethoxylate (e.g. C_{12-15} alcohol, 7 EO) | 10 - 25% |
| | - sodium carbonate (as Na_2CO_3) | 14 - 22% |
| 30 | - soluble silicate (as $\text{Na}_2\text{O}, 2\text{SiO}_2$) | 1 - 5% |
| | - zeolite (as NaAlSiO_4) | 25 - 35% |
| 35 | - sodium sulfate (as Na_2SO_4) | 0 - 10% |
| | - carboxymethylcellulose | 0 - 2% |
| | - polymers (e.g. maleic/acrylic acid copolymer, PVP, PEG) | 1 - 3% |
| 40 | - enzymes | 0 - 5% |
| | - minor ingredients (e.g. suds suppressors, perfume) | 0 - 5% |
| 45 | | |

5) An aqueous liquid detergent composition comprising

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| 50 | - linear alkylbenzenesulfonate (calculated as acid) | 15 - 21% |
| | - alcohol ethoxylate (e.g. C_{12-15} alcohol, 7 EO or C_{12-15} alcohol, 5 EO) | 12 - 18% |

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| | - soap as fatty acid (e.g. oleic acid) | 3 - 13% |
| | - alkenylsuccinic acid (C ₁₂₋₁₄) | 0 - 13% |
| 5 | - aminoethanol | 8 - 18% |
| | - citric acid | 2 - 8% |
| | - phosphonate | 0 - 3% |
| 10 | - polymers (e.g. PVP, PEG) | 0 - 3% |
| | - borate (as B ₄ O ₇) | 0 - 2% |
| | | 0 - 3% |
| 15 | - ethanol | 8 - 14% |
| | - propylene glycol | 0 - 5% |
| | - enzymes | |
| 20 | - minor ingredients (e.g. dispersants, suds suppressors, perfume, optical brightener) | 0 - 5% |
| 25 | 6) An aqueous structured liquid detergent composition comprising | |
| | - linear alkylbenzenesulfonate (calculated as acid) | 15 - 21% |
| 30 | - alcohol ethoxylate (e.g. C ₁₂₋₁₅ alcohol, 7 EO, or C ₁₂₋₁₅ alcohol, 5 EO) | 3 - 9% |
| | | 3 - 10% |
| 35 | - soap as fatty acid (e.g. oleic acid) | 14 - 22% |
| | - zeolite (as NaAlSiO ₄) | 9 - 18% |
| | - potassium citrate | |
| 40 | - borate (as B ₄ O ₇) | 0 - 2% |
| | - carboxymethylcellulose | 0 - 2% |
| | | 0 - 3% |
| 45 | - polymers (e.g. PEG, PVP) | |
| | - anchoring polymers such as, e.g., lauryl methacrylate/acrylic acid copolymer; molar ratio 25:1; MW 3800 | 0 - 3% |
| 50 | - glycerol | 0 - 5% |
| | - enzymes | 0 - 5% |
| 55 | - minor ingredients | |

(e.g. dispersants, suds suppressors, perfume,
optical brighteners) 0 - 5%

7) A detergent composition formulated as a granulate having a
5 bulk density of at least 600 g/l comprising

- fatty alcohol sulfate 5 - 10%
- ethoxylated fatty acid monoethanolamide 3 - 9%
- 10 - soap as fatty acid 0 - 3%
- sodium carbonate (as Na_2CO_3) 5 - 10%
- soluble silicate (as $\text{Na}_2\text{O}, 2\text{SiO}_2$) 1 - 4%
- 15 - zeolite (as NaAlSiO_4) 20 - 40%
- sodium sulfate (as Na_2SO_4) 2 - 8%
- 20 - sodium perborate (as $\text{NaBO}_3 \cdot \text{H}_2\text{O}$) 12 - 18%
- TAED 2 - 7%
- polymers (e.g. maleic/acrylic acid copolymer,
25 PEG) 1 - 5%
- enzymes 0 - 5%
- minor ingredients (e.g. optical brightener,
30 suds suppressors, perfume) 0 - 5%

8) A detergent composition formulated as a granulate comprising

- linear alkylbenzenesulfonate
(calculated as acid) 8 - 14%
- 35 - ethoxylated fatty acid monoethanolamide 5 - 11%
- soap as fatty acid 0 - 3%
- 40 - sodium carbonate (as Na_2CO_3) 4 - 10%
- soluble silicate (as $\text{Na}_2\text{O}, 2\text{SiO}_2$) 1 - 4%
- zeolite (as NaAlSiO_4) 30 - 50%
- 45 - sodium sulfate (as Na_2SO_4) 3 - 11%
- sodium citrate (as $\text{C}_6\text{H}_5\text{Na}_3\text{O}_7$) 5 - 12%
- 50 - polymers (e.g. PVP,
maleic/acrylic acid copolymer, PEG) 1 - 5%
- enzymes 0 - 5%

- minor ingredients (e.g. suds suppressors, perfume) 0 - 5%
- 5 9) A detergent composition formulated as a granulate comprising
- linear alkylbenzenesulfonate (calculated as acid) 6 - 12%
 - nonionic surfactant, 1 - 4%
 - 10 - soap as fatty acid 2 - 6%
 - sodium carbonate (as Na_2CO_3) 14 - 22%
 - 15 - zeolite (as NaAlSiO_4) 18 - 32%
 - sodium sulfate (as Na_2SO_4) 5 - 20%
 - sodium citrate (as $\text{C}_6\text{H}_5\text{Na}_3\text{O}_7$) 3 - 8%
 - 20 - sodium perborate (as $\text{NaBO}_3 \cdot \text{H}_2\text{O}$) 4 - 9%
 - bleach activator (e.g. NOBS or TAED) 1 - 5%
 - 25 - carboxymethylcellulose 0 - 2%
 - polymers (e.g. polycarboxylate or PEG) 1 - 5%
 - enzymes 0 - 5%
 - 30 - minor ingredients (e.g. optical brightener, perfume) 0 - 5%
- 35 10) An aqueous liquid detergent composition comprising
- linear alkylbenzenesulfonate (calculated as acid) 15 - 23%
 - alcohol ethoxysulfate 8 - 15%
 - 40 (e.g. C_{12-15} alcohol, 2-3 EO)
 - alcohol ethoxylate 3 - 9%
 - (e.g. C_{12-15} alcohol, 7 EO, or C_{12-15} alcohol, 5 EO)
 - 45 - soap as fatty acid (e.g. lauric acid) 0 - 3%
 - aminoethanol 1 - 5%
 - 50 - sodium citrate 5 - 10%
 - hydrotrope (e.g. sodium toluenesulfonate) 2 - 6%
 - borate (as B_4O_7) 0 - 2%

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|----|--|--------|
| | - carboxymethylcellulose | 0 - 1% |
| | - ethanol | 1 - 3% |
| 5 | - propylene glycol | 2 - 5% |
| | - enzymes | 0 - 5% |
| 10 | - minor ingredients (e.g. polymers, dispersants, perfume, optical brighteners) | 0 - 5% |

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| | 11) An aqueous liquid detergent composition comprising | |
| | - linear alkylbenzenesulfonate | |
| 15 | (calculated as acid) | 20 - 32% |
| | - alcohol ethoxylate | |
| | (e.g. C ₁₂₋₁₅ alcohol, 7 EO, | |
| | or C ₁₂₋₁₅ alcohol, 5 EO) | 6 - 12% |
| 20 | - aminoethanol | 2 - 6% |
| | - citric acid | 8 - 14% |
| 25 | - borate (as B ₄ O ₇) | 1 - 3% |
| | - polymer (e.g. maleic/acrylic acid copolymer, | |
| | anchoring polymer such as, e.g., | |
| | lauryl methacrylate/acrylic acid | |
| 30 | copolymer) | 0 - 3% |
| | - glycerol | 3 - 8% |
| | - enzymes | 0 - 5% |
| 35 | - minor ingredients (e.g. hydrotropes, dispersants, perfume, optical brighteners) | 0 - 5% |

| | | |
|----|--|----------|
| 40 | 12) A detergent composition formulated as a granulate having a bulk density of at least 600 g/l comprising | |
| | - anionic surfactant (linear alkylbenzenesulfonate, alkyl sulfate, alpha-olefinsulfonate, alpha-sulfo fatty acid | |
| 45 | methyl esters, alkanesulfonates, soap) | 25 - 40% |
| | - nonionic surfactant (e.g. alcohol ethoxylate) | 1 - 10% |
| 50 | - sodium carbonate (as Na ₂ CO ₃) | 8 - 25% |
| | - soluble silicates (as Na ₂ O, 2SiO ₂) | 5 - 15% |
| | - sodium sulfate (as Na ₂ SO ₄) | 0 - 5% |

35

- zeolite (as NaAlSiO_4) 15 - 28%
- sodium perborate (as $\text{NaBO}_3 \cdot 4\text{H}_2\text{O}$) 0 - 20%
- 5 - bleach activator (TAED or NOBS) 0 - 5%
- enzymes 0 - 5%
- minor ingredients 0 - 3%
- 10 (e.g. perfume, optical brighteners)

13) Detergent formulations as described in 1) - 12) wherein all or part of the linear alkylbenzenesulfonate is replaced by (C_{12} - C_{18}) alkyl sulfate .

14) A detergent composition formulated as a granulate having a bulk density of at least 600 g/l comprising

- 20 - (C_{12} - C_{18}) alkyl sulfate 9 - 15%
- alcohol ethoxylate 3 - 6%
- polyhydroxy alkyl fatty acid amide 1 - 5%
- 25 - zeolite (as NaAlSiO_4) 10 - 20%
- layered disilicate (e.g. SK56 from Hoechst) 10 - 20%
- 30 - sodium carbonate (as Na_2CO_3) 3 - 12%
- soluble silicate (as $\text{Na}_2\text{O}, 2\text{SiO}_2$) 0 - 6%
- 35 - sodium citrate 4 - 8%
- sodium percarbonate 13 - 22%
- TAED 3 - 8%
- 40 - polymers (e.g. polycarboxylates and PVP) 0 - 5%
- enzymes 0 - 5%
- 45 - minor ingredients (e.g. optical brightener, photo bleach, perfume, suds suppressors) 0 - 5%

50 15) A detergent composition formulated as a granulate having a bulk density of at least 600 g/l comprising

- (C_{12} - C_{18}) alkyl sulfate 4 - 8%

| | | |
|----|---|----------|
| | - alcohol ethoxylate | 11 - 15% |
| | - soap | 1 - 4% |
| 5 | - zeolite MAP or zeolite A | 35 - 45% |
| | - sodium carbonate (as Na_2CO_3) | 2 - 8% |
| | - soluble silicate (as $\text{Na}_2\text{O}, 2\text{SiO}_2$) | 0 - 4% |
| 10 | - sodium percarbonate | 13 - 22% |
| | - TAED | 1 - 8% |
| 15 | - carboxymethyl cellulose | 0 - 3% |
| | - polymers (e.g. polycarboxylates and PVP) | 0 - 3% |
| | - enzymes | 0 - 5% |
| 20 | - minor ingredients (e.g. optical brightener, phosphonate, perfume) | 0 - 3% |

25 16) Detergent formulations as described in 1) - 15) which contain a stabilized or encapsulated peracid, either as an additional component or as a substitute for already specified bleach systems.

30 17) Detergent compositions as described in 1), 3), 7), 9) and 12) wherein perborate is replaced by percarbonate.

18) Detergent compositions as described in 1), 3), 7), 9), 12), 14) and 15) which additionally contain a manganese catalyst.

35 The manganese catalyst may, e.g., be one of the compounds described in "Efficient manganese catalysts for low-temperature bleaching", Nature, 369, p. 637-639, 1994.

19) Detergent composition formulated as a nonaqueous detergent
40 liquid comprising a liquid nonionic surfactant such as, e.g., linear alkoxylated primary alcohol, a builder system (e.g. phosphate), enzyme and alkali. The detergent may also comprise anionic surfactant and/or a bleach system.

45 The enzyme of interest of the invention may be incorporated in

concentrations conventionally employed in detergents. It is at present contemplated that, in the detergent composition of the invention, the enzyme in question with reduced allergenicity may be added in an amount corresponding to 0.001-100 mg of 5 enzyme per liter of wash liquor.

Dishwashing composition

The polypeptides of the invention with reduced allergenicity may also advantageously be used in dishwashing detergents.

10

Dishwashing detergent compositions comprise a surfactant which may be anionic, non-ionic, cationic, amphoteric or a mixture of these types. The detergent will contain 0-90% of non-ionic surfactant such as low- to non-foaming ethoxylated propoxylated 15 straight-chain alcohols.

The detergent composition may contain detergent builder salts of inorganic and/or organic types. The detergent builders may be subdivided into phosphorus-containing and non-phosphorus- 20 containing types. The detergent composition usually contains 1-90% of detergent builders.

Examples of phosphorus-containing inorganic alkaline detergent builders, when present, include the water-soluble salts 25 especially alkali metal pyrophosphates, orthophosphates, and polyphosphates. An example of phosphorus-containing organic alkaline detergent builder, when present, includes the water-soluble salts of phosphonates. Examples of non-phosphorus-containing inorganic builders, when present, include water- 30 soluble alkali metal carbonates, borates and silicates as well as the various types of water-insoluble crystalline or amorphous alumino silicates of which zeolites are the best-known representatives.

35 Examples of suitable organic builders include the alkali metal, ammonium and substituted ammonium, citrates, succinates, malonates, fatty acid sulphonates, carboxymethoxy succinates, ammonium polyacetates, carboxylates, polycarboxylates, amino-

polycarboxylates, polyacetyl carboxylates and polyhydroxysulphonates.

Other suitable organic builders include the higher molecular weight polymers and co-polymers known to have builder properties, for example appropriate polyacrylic acid, polymaleic and polyacrylic/polymaleic acid copolymers and their salts.

The dishwashing detergent composition may contain bleaching agents of the chlorine/bromine-type or the oxygen-type. Examples of inorganic chlorine/bromine-type bleaches are lithium, sodium or calcium hypochlorite and hypobromite as well as chlorinated trisodium phosphate. Examples of organic chlorine/bromine-type bleaches are heterocyclic N-bromo and N-chloro imides such as trichloroisocyanuric, tribromoisocyanuric, dibromoisocyanuric and dichloroisocyanuric acids, and salts thereof with water-solubilizing cations such as potassium and sodium. Hydantoin compounds are also suitable.

The oxygen bleaches are preferred, for example in the form of an inorganic persalt, preferably with a bleach precursor or as a peroxy acid compound. Typical examples of suitable peroxy bleach compounds are alkali metal perborates, both tetrahydrates and monohydrates, alkali metal percarbonates, per-silicates and perphosphates. Preferred activator materials are TAED and glycerol triacetate.

The dishwashing detergent composition of the invention may be stabilized using conventional stabilizing agents for the enzyme(s), e.g. a polyol such as e.g. propylene glycol, a sugar or a sugar alcohol, lactic acid, boric acid, or a boric acid derivative, e.g. an aromatic borate ester.

The dishwashing detergent composition of the invention may also contain other conventional detergent ingredients, e.g. defloculant material, filler material, foam depressors, anti-corrosion agents, soil-suspending agents, sequestering agents, anti-soil redeposition agents, dehydrating agents, dyes, bacteri-

cides, fluorescers, thickeners and perfumes.

Finally, the polypeptide of the invention may be used in conventional dishwashing detergents, e.g. in any of the detergents 5 described in any of the following patent publications:

EP 518719, EP 518720, EP 518721, EP 516553, EP 516554,
EP 516555, GB 2200132, DE 3741617, DE 3727911, DE 4212166,
DE 4137470, DE 3833047, WO 93/17089, DE 4205071, WO 52/09680,
10 WO 93/18129, WO 93/04153, WO 92/06157, WO 92/08777, EP 429124,
WO 93/21299, US 5141664, EP 561452, EP 561446, GB 2234980,
WO 93/03129, EP 481547, EP 530870, EP 533239, EP 554943,
EP 346137, US 5112518, EP 318204, EP 318279, EP 271155,
EP 271156, EP 346136, GB 2228945, CA 2006687, WO 93/25651,
15 EP 530635, EP 414197, US 5240632.

Textile applications

Further polypeptides, including enzymes, of the invention with reduced allergenicity may be used in applications for purposes 20 in the textile industry involving handling of enzyme granulates or powders.

Examples of textile applications are listed below:

25 i. Cellulolytic enzymes are widely used in the finishing of denim garments in order to provide a localized variation in the colour density of the fabric (Enzyme facilitated "stone wash").

ii. Bio-Polishing

30 Also cellulolytic enzymes find use in the bio-polishing process. Bio-Polishing is a specific treatment of the yarn surface which improves fabric quality with respect to handle and appearance without loss of fabric wettability. Bio-polishing may be obtained by applying the method described e.g. in WO 35 93/20278.

iii. Desizing

During the weaving of textiles, the threads are exposed to

considerable mechanical strain. In order to prevent breaking, they are usually reinforced by coating (sizing) with a gelatinous substance (size). The most common sizing agent is starch in native or modified form. A uniform and durable finishing can thus be obtained only after removal of the size from the fabric, the so-called desizing. Desizing of fabrics sized with a size containing starch or modified starch is preferably facilitated by use of amylolytic enzymes.

10 iiiii. Bleach clean-up

In bleach clean-up catalases may serve to remove excess hydrogen peroxide.

iiiiii. Silk degumming

15 Removal of gum on silk fibers with protease. (Application sheet "Novo Enzymes for Silk Degumming" is available on request)

Personal care applications

Also in the personal care technical field polypeptides according to the invention are of interest. In the following are listed examples of uses.

1) Proteases:

Proteases are well-known active ingredients for cleaning of contact lenses. They hydrolyse the proteinaceous soil on the lens and thereby makes it soluble. Removal of the protein soil is essential for the wearing comfort.

Proteases are also effective ingredients in skin cleaning products, where they remove the upper layer of dead keratinaceous skin cells and thereby makes the skin look brighter and more fresh.

Proteases are also used in oral care products, especially for cleaning of dentures, but also in dentifrices.

2) Lipases:

Lipases can be applied for cosmetic use as active ingredients

in skin cleaning products and anti-acne products for removal of excessive skin lipids, and in creams and lotions as active ingredients for skin care.

5 Lipases can also be used in hair cleaning products (e.g. shampoos) for effective removal of sebum and other fatty material from the surface of hair.

Lipases are also effective ingredients in products for cleaning
10 of contact lenses, where they remove lipid deposits from the lens surface.

3) Oxidoreductases:

There are many well-known Personal Care applications of
15 oxidoreductases. The most common is an oxidase (usually glucoseoxidase) with substrate (e.g. glucose) that ensures production of H_2O_2 , which then will initiate the oxidation of for instance SCN^- or I^- into antimicrobial reagents ($SCNO^-$ or I_2) by a peroxidase (usually lactoperoxidase). This enzymatic
20 complex is known in nature from e.g. milk and saliva.

It is being utilised commercially as antimicrobial system in oral care products (mouth rinse, dentifrice, chewing gum) where it also can be combined with an amyloglucosidase to produce the
25 glucose. These systems are also known in cosmetic products for preservation.

Antimicrobial systems comprising the combination of an oxidase and a peroxidase are known in the cleaning of contact lenses.

30

Other applications of oxidoreductases are the application of oxidases, peroxidases and laccases in oxidative hair dyeing.

Further, free radicals formed on the surface of the skin (and
35 hair) known to be associated with the ageing process of the skin (spoilage of the hair).

The free radicals activate chain reactions that lead to

destruction of fatty membranes, collagen, and cells.

The application of free radical scavengers such as Superoxide dismutase into cosmetics is well-known (R.L. Goldemberg, DCI, Nov. 93, 48-52).

5

Protein disulfide isomerase (PDI) is also an oxidoreductase. It can be utilised for waving of hair (reduction and reoxidation of disulfide bonds in hair) and repair of spoiled hair (where the damage is mainly reduction of existing disulfide bonds).

10

4) Glucanases/Carbohydrases.

Plaque formed on the surface of teeth are composed mainly of polysaccharides. They stick to the surface of the teeth and the microorganisms. The polysaccharides are mainly α -1,6 bound glucose (dextran) and α -1,3 bound glucose (mutan). The application of different types of glucanases such as mutanase and dextranase helps hydrolysing the sticky matrix of plaque, making it easier to remove by mechanical action.

20 Also other kinds of biofilm for instance the biofilm formed in lens cases can be removed by the action of glucanases.

5) Antimicrobial polypeptides.

Antimicrobial polypeptides have widespread applications such as 25 preservation of cosmetic products, anti-acne products, deodorants and shampoos.

Food and Feed

The polypeptides with reduced allergenicity according to the 30 invention may further advantageously be used in food- and feedstuff. Specifically relevant polypeptides are enzymes selected from the group of proteases, β -glucanases, amylases, pectinases, α -galactosidases, phytases, xylanases and lipases.

35 Use of Zipper domains

Finally the invention relates to the use of Zipper domains for reducing allergenicity of polypeptides and may be any molecules capable of self-oligomerizing microbially expressed

polypeptides.

Examples of a number of Zipper domains have already been described previously.

5

In an embodiment the Zipper domain is a Leucine Zipper.

The Leucine Zipper may be any known Leucine Zipper which, grafted to a polypeptide, is capable of self-oligomerizing as
10 a result of association of parallel α -helical coils of two or more Leucine Zippers.

In a specific embodiment the Leucine Zipper is the yeast transcriptional factor GCN4 or modifications thereof.

15

If it is desired to obtain a hetero-dimeric molecule the Zipper domain may advantageously be a Fos Leucine Zipper and a Jun Leucine Zipper.

20 In another embodiment of the invention the Zipper domain is a four helical bundle or a modification thereof.

The Zipper domains may advantageously be used for reducing allergenicity of polypeptides in detergents, household
25 articles, agrochemicals, personal care products, cosmetics, toiletry, pharmaceuticals, composition used for treating textiles, food and feed etc.

Specifically the polypeptides comprising at least one Zipper
30 domain may advantageously be used in compositions and/or in context with e.g. the industrial applications previously described.

The present invention is further illustrated in the following
35 examples which should not, in any manner, be considered to limit the scope of the present invention.

METHODS AND MATERIALS**Host cells:**

Escherichia coli JM105 (Yanisch-Perron et al. Gene, 33, p. 5 103-119, 1985)

Epicurian coli^{*} XL1-Blue Cells (Stratagene Cloning Systems, Ca., USA)

Escherichia coli MC1061 (Casadaban, M.J. et al., J. Mol.Biol. 138, p. 179-207, 1980).

10

Vector:

The pFab3 expression vector is the ancestor of pFab4 (Ørum, H. et al., Nucleic Acids Research, 21, p. 4491-4498, 1993). The vector contains a pelB signal sequence (Lei et al., J. of Bac-
15 teriol, vol. 169, p. 4379-4383, 1987) which is under control of the inducible lacZ promoter. A SfiI site in the pelB signal makes it possible to clone the desired sequence, so that the geneproduct will be expressed In Frame with the signal sequence.

20

Parts of the pFab3 vector was not relevant for this study wherefor it was removed by SfiI and XmaI digestion. These sites were then used as sites for introducing the PCR fragment as described below. In contrast to the referred pFab4, pFab3 con-
25 tains 131 bp region between the start codons of the lacZ and the pelB signal.

Primers:**30 A-termamyl (SEQ ID NO 9):**

5'-CA GTC ACA GAT CCT CGC GAA TTG GCC CAG CCG GCC ATG GCC GCA
AAT CTT AAT GGG ACG CTG ATG-3'

B-termamyl (SEQ ID NO 10):

35 5'- CAT TCG CGA GGA CCC GGG CGG GGT GGA CGG TTT CGG TCT TTG
AAC ATA AAT TGA AAC CGA CCC-3'

The underlined nucleotides correspond to the termamyl sequence.

Primer A-termamyl also includes the SfiI restriction site and the last two codons of the pelB signal. Primer B-termamyl includes a linker sequence (a short hinge domain of IgG3) (Plückthun, A. et al., Biochemistry, 31, p. 1579-1584, 5 1992) and a XmaI cloning site.

Plasmids:

pDN1528 (PCT/DK94/00370)

10 **Signal sequence:**

pelB (Lei et al., J. of Bacteriol, vol. 169, p. 4379-4383, 1987)

Linker sequence:

15 Part of IgG, hinge (Plückthun, A. et al., Biochemistry, 31, p. 1579-1584, 1992)

Materials:

fmol™ DNA-sequencing system (Cat.:#Q4100, Promega Corporation, 20 WI, USA).

α-amylase EPS assay (Cat.:#1442295, Boehringer Mannheim GmbH, Mannheim, Germany)

Enzymes:

25 Termamyl® (available from Novo Nordisk A/S)

SfiI (Cat.:#R6391, Promega Corporation, WI, USA)

XmaI (Cat.:#R6491, Promega Corporation, WI, USA)

SacI (Cat.:#R6061, Promega Corporation, WI, USA)

T4-DNA ligase (Cat.:#M1801, Promega Corporation, WI, USA)

30 AmpliTaq® DNA Polymerase (PartNo.:N801-0060, Perkin Elmer, Roche Molecular Systems, New Jersey, USA.)

Solutions:

PCR reaction buffer: dNTP(0.25mM of each), MgCl₂ 2.5mM and

35 1x PCR reaction buffer-II (PartNo.:N808-0009, Perkin Elmer, Roche Molecular Systems, New Jersey, USA.)

T4-DNA ligase buffer (Cat.:#M1801, Promega Corporation, WI, USA)

- SOC medium (Sambrook, J. et al., 1989, Molecular Cloning. A Laboratory Manual. Second edition. Cold Spring Harbor Laboratory, New York, USA)
- 2xTY medium (Ausubel, F.M. et al. (Editors), 1994
- 5 LB-agar Current Protocols in Molecular Biology, John Wiley & Sons, Inc. and Greene Publishing Associates, Inc., New York, USA)
- LB-medium
- PEG-8000 (Cat.:#P2139, Sigma Chemical Company, MO, USA).
- PBS tween 20 Ausubel, F.M. et al. (Editors), 1994
- 10 Alkaline phosphatase Buffer (pH=9.0)
- NaCl 5.844 g
- MgCl₂·6H₂O 1.02 g
- Diethanol amine 10.51 g
- The pH is adjusted to 9.0 with HCl, and Milli-Q water is
- 15 applied to 1 litre.

Stop-solution

- EDTA, disodium 74.44 g
- K₂HPO₄ 174.2 g
- 20 NAH₂ 0.2 g
- The pH is adjusted to 10 with about 22.5 g KOH in Milli-Q water to 1 litre.

Equipment:

- 25 Bio-Rad E. coli pulser(#165-2103,Bio-Rad Laboratories, Ca., USA)
- Horizon 11.14 Agarose Gel apparatus. (#580-1068IL, Life Technologies, Inc.,MD, USA).
- Applied Biosystems 394 DNA/RNA synthesizer (Applied Biosystems,
- 30 CA, USA).
- Thermocycler Varius V 45(Hans Landgraf, GmbH, Langenhagen, Germany.)
- Mini-PROTEAN II Electrophoresis Cell (#165-2940,Bio-Rad Laboratories, Ca., USA)
- 35 The Semi Dry Electroblotter (JKA-Biotech, Denmark)
- HiTrap™ chelating column (Code no. 17-0409-01, Pharmacia LKB, Biotechnology AB, Uppsala, Sweden)
- ELISA reader: Ceres 900 HDi

Methods:

All general techniques are performed according to Sambrook, J. et al., Molecular Cloning. A Laboratory Manual. Second edition. Cold Spring Harbor Laboratory, New York, USA, 1989, and/or according to Ausubel, F.M. et al. (Editors), Current Protocols in Molecular Biology, John Wiley & Sons, Inc. and Greene Publishing Associates, Inc., New York, USA, 1994)

Geneclean II procedure (BIO 101, Inc., CA, USA).

10

PCR amplification of the gene encoding Termamyl®.

The PCR reaction is performed in 50 µl volume PCR reaction-buffer, 1 µM of each primer A- and B-termamyl and 10 ng of the DNA template.

15

Reaction mixtures are overlaid with mineral oil and kept at 94°C for 5 minutes. Then 0.5 µl of AmpliTaq® (5 U/µl) is added. The mixtures are kept at annealing temperature 70°C for 5 minutes and at elongation temperature 72°C for 2 minutes.

20

After this initial incubation the mixtures cycle 30 times (94°C 1 minute, 70°C 1 minute, 72°C 1 minute) followed by incubation at 72°C for 10 minutes using a PCR Thermocycler Varius V 45.

25

Preparation of a sequence encoding Leucine Zipper from GCN4 and linker

The four oligonucleotides are synthesized on Applied Biosystems 394 DNA/RNA synthesizer according to protocols of the supplier.

30 After synthesis the oligonucleotides are purified using denaturing polyacrylamide gel electrophoresis according to (Ausubel, F.M. et al., supra, 1994). 20 pmol of each oligonucleotide are mixed in a total volume of 40 µl of 100 mM NaCl, annealed by incubation at 95°C for 5 minutes and cooled slowly 35 to 16°C over a period of 3 hours, this annealing mixture is used in ligation. The four oligonucleotides are as follows:

Antisense Zip Cys (1) (XmaI-SacI) (SEQ ID NO 3)

5'-CA GCC CCC ACA GCC CCC ACG TTC ACC AAC AAG CTT TTT CAG ACG
AGC AAC TTC GTT TTC CAG GTG GTA G-3'

5 Antisense Zip (2), (XmaI-SacI) (SEQ ID NO 4)

5'-P-TT TTT GGA CAG CAG TTC TTC AAC TTT GTC TTC CAG CTG TTT CAT
TCG CGA GGA C-3'

Sense Zip (1), (XmaI-SacI) (SEQ ID NO 5)

10 5'-CCG GGT CCT CGC GAA TGA AAC AGC TGG AAG ACA AAG TTG AAG AAC
TGC TGT CCA AAA ACT ACC ACC-3'

Sense Zip Cys (2), (XmaI-SacI) (SEQ ID NO 6)

5'-P-TG GAA AAC GAA GTT GCT CGT CTG AAA AAG CTT GTT GGT GAA CGT
15 GGG GGC TGT GGG GGC TGA GCT-3'

P indicates oligonucleotides with a phosphoryl group at the 5'-ends.

20 Transformation of XL-1 blue E. coli

The transformation is carried out by electroporation. For this purpose *Epicurian coli*[®] XL1-Blue Electroporation competent Cells are used, 3 µl of ligated DNA is used per 80 µl of cells. The electroporation is performed using a Bio-Rad E. coli pulser set 25 at 25 µF, 2.5 kV and 200 Ohms.

Transformation of E.coli JM105

Transformation of E. coli JM105 is done by adding 3 µl of the
30 ligation mixture per 100 µl of heat-shock competent cells. The preparation and transformation of the cells are made essentially as described in (Sambrook et al. 1989, supra.)

Expression and isolation of periplasmic polypeptides.

35 The expression of Termamyl®-dimer in E. coli JM105 is done as follows. An overnight culture of JM105 harbouring the pAZ-1 plasmid in 2XTY medium with 100 µg/ml Ampicillin and 1% D(+)-Glucose is prepared by transferring a single colony to the

media and incubating this at 37°C for 16 hours with vigorously shaking. 100 µl of this is used as starter culture of 100 ml 2XTY medium with 100 µg/ml Ampicillin and 0.1% D(+)-Glucose, which in a 1 L shake flask is incubated at 37°C with vigorously shaking. When OD550=1.0 is reached, the temperature is adjusted to 30°C and the expression is induced by adding isopropyl-β-D-thiogalactopyranoside (IPTG) to a final concentration of within 1-5 mM. The induction is carried out for 5 hours, then the cells are pelleted by gentle centrifugation and given an osmotic shock for releasing the polypeptides present in the periplasmic space of the cells. This can be performed according to the procedure of Neu, H.C. and Heppel, L.A., J. Biol. Chem. 240, p. 3685-3692, 1965.

15 Characterization of expressed Termamyl®-Zipper dimer

The periplasmic fraction of induced and non-induced cells harbouring the pAZ-1 plasmid are analyzed on an SDS-page gel 4-20% Acrylamide (Laemmli, Nature, 227, p. 680, 1970) using the Mini-Protean II (Bio-Rad Laboratories, Richmond, Ca, USA). Samples are run with or without reducing agent dithiothreitol. Dithiothreitol (DTT) also termed Clelands reagent is a reducing agent capable of quantitatively reducing disulfide bonds (Cleland, W.W., Biochemistry, 3, p. 480, 1964). One gel is stained with Coomassie Brilliant Blue G250 according to (Neuhoff, et al., Electrophoresis, 9, p. 255-262, 1988) and another gel is used for blotting the polypeptides onto a PVDF membrane Immobilin-P® (Cat.:#IPVH 20200, Millipore Corporation, MA, USA) using The Semidry Electroblotter. The membranes are probed using anti-Termamyl antibodies raised in rabbits against the Termamyl® as the primary antibody (as described in Ausubel, F.M. et al. chapter 11 section 12 and 13, supra, 1994) and anti-rabbit IgG horseradish peroxidase conjugated (Cat.:L42007, medac, GmbH, Hamburg, Germany) as secondary antibody. The polypeptides are detected with ECL™ Western blotting detection reagent (Cat.:#RPN2106, Amersham Int., Buckinghamshire, England) and recording the light emission on ordinary X-ray film.

Purification of Termamyl® Zipper dimer

The expressed Termamyl® Zipper dimer was purified from the fermentation broth. This was done using the attached poly-His tail as the affinity tag. More specifically the purification was performed using a 5 ml HiTrap™ chelating column according to the recommendations of the supplier. Further details concerning the IMAC (Immobilized Metal Affinity Chromatography) procedure is describe in Yip et al., (1994), Molecular Biotechnology, vol. 1, p. 151-164; Fatiadi et al., (1987), CRC Critical Rev. Anal. Chem. 18, p. 1-44.

Protein determination

After purification and dialysis of the Termamyl® Zipper dimer sample, spectral measurements were performed. The optical density of the sample at 280 nm were used to calculate the protein concentration of the sample. For this purpose the Lambert Beer law was used together with the calculated protein extinction coefficient of the Termamyl® Zipper dimer using the principals for this as described by Gill et al, Analytical Biochemistry, 182, p. 319-326, 1989.

ELISA procedure for determination of IgG₁ positive guinea pigs

ELISA microtiter plates are coated with rabbit anti-Termamyl® AAN 4080 K 452-453 1:4000 in carbonate buffer and incubated over night at 4°C. The next day the plates is blocked with 2% BSA for 1 hour and washes 3 times with PBS tween 20. Termamyl® PPX 3328 1 µg enzyme protein/ml is applied to the plates, incubated for 1 hour and then washed 3 times with PBS tween 20.

All guinea pig samples are applied to the ELISA plates with 25 µl sera and 25 µl PBS buffer, incubated for 3 hours and washed 3 times with PBS tween 20.

Then goat anti-guinea pig IgG₁ (diluted to 1:4000 in PBS buffer) is applied to the plates, incubated for 1 hour and washed 3 times with PBS tween 20. Alkaline phosphatase rabbit anti-goat is applied (diluted to 1:8000) and incubated for 1 hour, washed 2 times in PBS tween 20 and 1 time with diethanol amine buffer.

51

The alkaline phosphatase is developed using p-nitrophenyl phosphate for 30 minutes at 37°C and stopped with calcium/sodium buffer comprising EDTA (pH=10) and read at OD 405/650 using a ELISA reader.

5

6 double blinds are included on all ELISA plates.

Positive and negative sera values are calculated as the average blind values added 2 times the standard deviation. This gives 10 an accuracy of 95%.

The test is described more thoroughly in ED-9515452 available on request from Novo Nordisk A/S.

15

EXAMPLES

EXAMPLE 1

20 PCR amplification and cloning of the gene encoding Termamyl®.

The primers A-termamyl and B-termamyl were designed and synthesized on Applied Biosystems 394 DNA/RNA synthesizer.

The Termamyl® encoding gene was PCR amplified using the plasmid 25 pDN1528 containing the gene encoding Termamyl® as a template.

The PCR product, a 1.5 kb fragment, was purified by preparative agarose electrophoresis followed by the Geneclean-II procedure (BIO 101, Inc., Ca., USA).

30

EXAMPLE 2

Cloning of PCR product

35 The purified 1.5 kb DNA fragment containing the sequence encoding Termamyl® was digested with 10 U of SfiI per µg DNA at 50°C for 2 hours with the reaction mixture overlaid by mineral oil.

Following the Geneclean-II procedure the DNA fragment was further digested for 2 hours at 37°C with 10 U XmaI per µg DNA. The digested DNA was again purified using Geneclean-II procedures and finally ligated to the prepared SfiI and XmaI digested pFab3. The 10 µl ligation mixture included 0.2 µg of insert DNA and 0.2 µg of digested vector pFab3. The ligation was performed for 2 hours at 16°C and 14 hours at 4°C with 1 U of T4-DNA ligase.

- 10 The ligated material was used to transform *Epicurian coli*[®] XL1-Blue Electroporation competent Cells as described above.

EXAMPLE 3

15

Identification of correct clones

Immediately after the electroporation 1 ml of freshly made SOC medium was added and the transformed cells were vigorously shaken for 1 hour at 37°C, plated onto LB-agar plates containing 100 µg/ml Ampicillin and 12.5 µg/ml Tetracyclin and incubated overnight at 37°C. The next day clones were picked randomly, transferred to 14 ml polypropylene tubes containing 2 ml of LB medium containing 100 µg/ml Ampicillin and 12.5 µg/ml Tetracyclin. After overnight incubation at 37°C and shaking at 250 rpm, plasmid DNA minipreps were prepared according to Sambrook et al., supra, 1989. The isolated plasmid DNA was analyzed by digestion with SfiI and XmaI and the digested plasmid DNA was analyzed on 1% agarose, 1xTBE gel.

- 30 The appearance of a DNA fragment of 1.5 kb indicated the existence of clones containing the correct fragment size. Further verification of the cloned gene was done as DNA sequencing using the fmol[™] DNA-sequencing system from Promega Corporation. A construct with the correct DNA sequence of Termamyl[®] was
35 named pAZ- $\frac{1}{2}$.

EXAMPLE 4

Leucine Zipper

Introduction of a sequence encoding the Leucine Zipper of GCN4
5 a Yeast transcriptional activator (O'Shea et al. Science, 243,
p. 538-542, 1989) and also encoding a flexible C-terminal
extension peptide containing a Cysteine amino acid residue was
carried out using four overlapping oligonucleotides (see
methods section).

10

For ligation 5 μ l of the annealing mixture was added to the
T4-DNA-ligase buffer to which was added 5% PEG-8000, 1 Unit of
T4-DNA ligase and 0.1 pmol of XmaI and SacI digested pAZ- $\frac{1}{2}$.

15 The ligated material was used to transform E. coli JM105 as
described above.

EXAMPLE 5

20

Identification of clones containing the Termamyl®-Leucine
Zipper construct

Immediately after the transformation 1 ml of freshly made SOC
medium was added and the cells were vigorously shaken for 1
25 hour at 37°C, plated onto selective plates and incubated over-
night at 37°C.

The next day clones were picked randomly, transferred to 14 ml
polypropylene tubes containing 2 ml of LB medium containing 100
30 μ g/ml Ampicillin. After overnight incubation at 37°C and sha-
king at 250 rpm, plasmid DNA minipreps were prepared according
to (Sambrook et al., supra, 1989). The isolated plasmid DNA was
analyzed by digestion with NruI (introduced by the Leucine
Zipper DNA fragment), the digested and non-digested plasmid DNA
35 were analyzed on 1% agarose, 1xTBE gel. The appearance of line-
arized plasmid of 4606 bp in NruI digested samples indicated
the existence of clones comprising the Leucine Zipper fragment.
Further verification of the cloned fragment was done by sequ-

encing using the fmol™ DNA-sequencing system from Promega Corporation.

5 EXAMPLE 6

Expression of dimerized Termamyl®

JM105 cells harbouring the plasmid pAZ-1 were induced to express the fusion polypeptide *pelB* signal-Termamyl®-Linker-
10 Leucine Zipper as described above. Each fusion polypeptide dimerize with other identical fusion polypeptides during expression. Cells were given osmotic shock in order to release proteins present in the periplasma. Aliquots of the isolate from both induced and non-induced cells were analyzed on SDS-
15 PAGE. Samples were analyzed under reducing (sample with DTT) and non-reducing (sample without DTT) conditions. Polypeptide bands were visualised by staining with Coomassie Blue dye. Non-reduced samples of induced cells showed a distinct band at approximately 120 kDa (see figure 3) a band not present in
20 samples of non-induced cells. Reduced samples from induced cells showed a distinct band at approximately 60 kDa, while at the same time no band was seen at 120 kDa (see figure 4). In samples of non-induced cells no 60 kDa band were seen. A gel similar to the above were used to transfer the proteins to a
25 PVDF membrane via a Western blot procedure, as described above. The 120 kDa band of non-reduced samples was specifically recognized as Termamyl® confirming the expression of Termamyl® as a dimer (see figure 5).

30

EXAMPLE 7

α -amylase activity of unpurified Termamyl-Dimer.

As a test for α -amylase activity of the Termamyl®-dimer, a
35 sample of the periplasmic isolate was analyzed. It was estimated by electrophoretic analysis that this sample contained about 0.5 mg/ml of Termamyl®-dimer. Dilutions of the sample were tested in an α -amylase assay (see the Materials and

Methods section) and compared to dilutions of Termamyl® of known activity. This assay revealed that the dimer retained more than 50% of the wild-type activity.

5

EXAMPLE 8**Introduction of a purification tag**

To obtain a more pure expression product a purification tag was introduced at the C-terminal part of the Termamyl®-Zipper protein as an in-frame insertion between the Xma I and SacI sites of pAZ- $\frac{1}{2}$. This resulted in a nucleotide sequence encoding the Termamyl®-Zipper protein with a C-terminal tail consisting of a Factor Xa site and the amino acid sequence His-His-His (see sequence data). Four oligonucleotides were used for this purpose (See below).

The four oligonucleotides were synthesized on Applied Biosystems 394 DNA/RNA synthesizer according to protocols of the supplier. After synthesis, the oligonucleotides were purified using denaturing polyacrylamide gel electrophoresis according to (Ausubel, F.M. et al., supra, 1994).

20 pmol of each oligonucleotide were mixed with a total volume of 40 μ l of 100 mM NaCl, annealed by incubation at 95°C for 5 minutes and cooled slowly to 16°C over a period of 3 hours. This annealing mixture was used for ligation. The four oligonucleotides were as follows:

30 Antisense Zip-Xa-His (XmaI-SacI) (SEQ ID NO 7)

5'-CA ATG GTG ATG ACG ACC TTC GAT GCC CCC ACA GCC CCC ACG TTC
ACC AAC AAG CTT TTT CAG ACG AGC AAC TTC GTT TTC CAG GTG GTA G-
3'

35 Antisense Zip₁ (XmaI-SacI) (SEQ ID NO 4)

5'-P-TT TTT GGA CAG CAG TTC TTC AAC TTT GTC TTC CAG CTG TTT CAT
TCG CGA GGA C-3'

Sense Zip, (XmaI-SacI) (SEQ ID NO 5)

5'-CCG GGT CCT CGC GAA TGA AAC AGC TGG AAG ACA AAG TTG AAG AAC
TGC TGT CCA AAA ACT ACC ACC-3'

5 Sense Zip-Xa-His, (XmaI-SacI) (SEQ ID NO 8)

5'-P-TG GAA AAC GAA GTT GCT CGT CTG AAA AAG CTT GTT GGT GAA CGT
GGG GGC TGT GGG GGC ATC GAA GGT CGT CAT CAC CAT TGA GCT-3'

P indicates oligonucleotides with a phosphoryl group at the
10 5'-ends.

The oligonucleotides were designed to have extruding overhangs
when hybridized: one matching the XmaI site and one matching
the SacI site of pAZ- $\frac{1}{2}$. The preparation of the pAZ- $\frac{1}{2}$ for
15 ligation with the hybridized oligonucleotides, the actual
ligation and transformation of competent *E. coli* JM105, were
performed essentially as described in example 4 and in the Met-
hods and Materials-section.

20 From this transformation positive clones were identified as
described in Example 5 and again the DNA sequence was verified
by DNA sequencing. Further, dimer Termamyl® was expressed as
described in Example 6.

25

EXAMPLE 9Allergenicity trails of dimer Termamyl®

20 Dunkin Hartley guinea pigs were exposed to 1.0 μ g monomer
Termamyl® and 1.0 μ g dimer Termamyl® by intratracheal dosage as
30 described ED-9513462 available on request from Novo Nordisk
A/S.

All guinea pigs were tested for the production of IgG₁ (indicat-
ing an allergic response) during 8 days using the ELISA
35 procedure described above.

Figure 6 shows the number of Dunkin Hartley guinea pigs found
IgG₁ positive during the trail period.

It can be seen from figure 6 the number of guinea pigs being IgG₁ positive at any time during the trial period is reduced for the dimer Termamyl® in comparison to the monomer Termamyl®. This proves that the allergenicity of Termamyl® can be reduced 5 by coupling Termamyl® to a Zipper domain.

SEQUENCE LISTING

(1) GENERAL INFORMATION:

5

(i) APPLICANT:

- (A) NAME: Novo Nordisk A/S
 (B) STREET: Novo Alle
 (C) CITY: Bagsvaerd
 (E) COUNTRY: Denmark
 (F) POSTAL CODE (ZIP): DK-2880
 (G) TELEPHONE: +45 4444 8888
 (H) TELEFAX: +45 4449 3256

10

15 (ii) TITLE OF INVENTION: A process for the production of polypeptides

(iii) NUMBER OF SEQUENCES: 10

(iv) COMPUTER READABLE FORM:

20

- (A) MEDIUM TYPE: Floppy disk
 (B) COMPUTER: IBM PC compatible
 (C) OPERATING SYSTEM: PC-DOS/MS-DOS
 (D) SOFTWARE: PatentIn Release #1.0, Version #1.30B (EPO)

25

(2) INFORMATION FOR SEQ ID NO: 1:

(i) SEQUENCE CHARACTERISTICS:

30

- (A) LENGTH: 1593 base pairs
 (B) TYPE: nucleic acid
 (C) STRANDEDNESS: single
 (D) TOPOLOGY: linear

(ii) MOLECULE TYPE: cDNA

35

(iii) HYPOTHETICAL: NO

(iv) ANTI-SENSE: NO

40

(ix) FEATURE:

- (A) NAME/KEY: CDS
 (B) LOCATION: 1..1593

45

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 1:

GCA AAT CTT AAT GGG ACG CTG ATG CAG TAT TTT GAA TGG TAC ATG CCC 48
 Ala Asn Leu Asn Gly Thr Leu Met Gln Tyr Phe Glu Trp Tyr Met Pro
 1 5 10 15

50

AAT GAC GGC CAA CAT TGG AGG CGT TTG CAA AAC GAC TCG GCA TAT TTG 96
 Asn Asp Gly Gln His Trp Arg Arg Leu Gln Asn Asp Ser Ala Tyr Leu
 20 25 30

55

GCT GAA CAC GGT ATT ACT GGC GTC TGG ATT CCC CCG GCA TAT AAG GGA 144
 Ala Glu His Gly Ile Thr Ala Val Trp Ile Pro Pro Ala Tyr Lys Gly
 35 40 45

59

| | | |
|----|---|-----|
| | ACG AGC CAA GCG GAT GTG GGC TAC GGT GCT TAC GAC CTT TAT GAT TTA | 192 |
| | Thr Ser Gln Ala Asp Val Gly Tyr Gly Ala Tyr Asp Leu Tyr Asp Leu | |
| | 50 55 60 | |
| 5 | GGG GAG TTT CAT CAA AAA GGG ACG GTT CGG ACA AAG TAC GGC ACA AAA | 240 |
| | Gly Glu Phe His Gln Lys Gly Thr Val Arg Thr Lys Tyr Gly Thr Lys | |
| | 65 70 75 80 | |
| | GGA GAG CTG CAA TCT GCG ATC AAA AGT CTT CAT TOC CGC GAC ATC AAC | 288 |
| 10 | Gly Glu Leu Gln Ser Ala Ile Lys Ser Leu His Ser Arg Asp Ile Asn | |
| | 85 90 95 | |
| | GTT TAC GGG GAT GTG GTC ATC AAC CAC AAA GGC GGC GCT GAT GCG ACC | 336 |
| | Val Tyr Gly Asp Val Val Ile Asn His Lys Gly Gly Ala Asp Ala Thr | |
| 15 | 100 105 110 | |
| | GAA GAT GTA AOC GCG GTT GAA GTC GAT CCG GCT GAC CGC AAC CGC GTA | 384 |
| | Glu Asp Val Thr Ala Val Glu Val Asp Pro Ala Asp Arg Asn Arg Val | |
| | 115 120 125 | |
| 20 | ATT TCA GGA GAA CAC CTA ATT AAA GCG TGG ACA CAT TTT CAT TTT CCG | 432 |
| | Ile Ser Gly Glu His Leu Ile Lys Ala Trp Thr His Phe His Phe Pro | |
| | 130 135 140 | |
| 25 | GGG CGC GGC AGC ACA TAC AGC GAT TTT AAA TGG CAT TGG TAC CAT TTT | 480 |
| | Gly Arg Gly Ser Thr Tyr Ser Asp Phe Lys Trp His Trp Tyr His Phe | |
| | 145 150 155 160 | |
| | GAC GGA AOC GAT TGG GAC GAG TOC CGA AAG CTG AAC CGC ATC TAT AAG | 528 |
| 30 | Asp Gly Thr Asp Trp Asp Glu Ser Arg Lys Leu Asn Arg Ile Tyr Lys | |
| | 165 170 175 | |
| | TTT CAA GGA AAG GCT TGG GAT TGG GAA GTT TOC AAT GAA AAC GGC AAC | 576 |
| 35 | Phe Gln Gly Lys Ala Trp Asp Trp Glu Val Ser Asn Glu Asn Gly Asn | |
| | 180 185 190 | |
| | TAT GAT TAT TTG ATG TAT GCG GAC ATC GAT TAT GAC CAT OCT GAT GTC | 624 |
| | Tyr Asp Tyr Leu Met Tyr Ala Asp Ile Asp Tyr Asp His Pro Asp Val | |
| | 195 200 205 | |
| 40 | GCA GCA GAA ATT AAG AGA TGG GGC ACT TGG TAT GCG AAT GAA CTG CAA | 672 |
| | Ala Ala Glu Ile Lys Arg Trp Gly Thr Trp Tyr Ala Asn Glu Leu Gln | |
| | 210 215 220 | |
| 45 | TTG GAC GGT TTC CGT CTT GAT GCT GTC AAA CAC ATT AAA TTT TCT TTT | 720 |
| | Leu Asp Gly Phe Arg Leu Asp Ala Val Lys His Ile Lys Phe Ser Phe | |
| | 225 230 235 240 | |
| | TTG CGG GAT TGG GTT AAT CAT GTC AGG GAA AAA ACG GCG AAG GAA ATG | 768 |
| 50 | Leu Arg Asp Trp Val Asn His Val Arg Glu Lys Thr Gly Lys Glu Met | |
| | 245 250 255 | |
| | TTT ACG GTA GCT GAA TAT TGG CAG AAT GAC TTG GCG GCG CTG GAA AAC | 816 |
| | Phe Thr Val Ala Glu Tyr Trp Gln Asn Asp Leu Gly Ala Leu Glu Asn | |
| | 55 260 265 270 | |

60

| | | | | | | | | | | | | | | | | | |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| | TAT | TTG | AAC | AAA | ACA | AAT | TTT | AAT | CAT | TCA | GIG | TTT | GAC | GIG | COG | CIT | 864 |
| | Tyr | Leu | Asn | Lys | Thr | Asn | Phe | Asn | His | Ser | Val | Phe | Asp | Val | Pro | Leu | |
| | | 275 | | | | | | 280 | | | | | 285 | | | | |
| 5 | CAT | TAT | CAG | TTC | CAT | GCT | GCA | TOG | ACA | CAG | GGA | GGC | GGC | TAT | GAT | ATG | 912 |
| | His | Tyr | Gln | Phe | His | Ala | Ala | Ser | Thr | Gln | Gly | Gly | Gly | Tyr | Asp | Met | |
| | | 290 | | | | | 295 | | | | | 300 | | | | | |
| | AGG | AAA | TTG | CTG | AAC | GGT | ACG | GTC | GTT | TOC | AAG | CAT | COG | TTG | AAA | TOG | 960 |
| 10 | Arg | Lys | Leu | Leu | Asn | Gly | Thr | Val | Val | Ser | Lys | His | Pro | Leu | Lys | Ser | |
| | | 305 | | | | 310 | | | | | 315 | | | | | 320 | |
| | GTT | ACA | TTT | GTC | GAT | AAC | CAT | GAT | ACA | CAG | COG | GGG | CAA | TOG | CIT | GAG | 1008 |
| | Val | Thr | Phe | Val | Asp | Asn | His | Asp | Thr | Gln | Pro | Gly | Gln | Ser | Leu | Glu | |
| 15 | | | | | 325 | | | | | 330 | | | | | 335 | | |
| | TOG | ACT | GTC | CAA | ACA | TGG | TTT | AAG | COG | CIT | GCT | TAC | GCT | TTT | ATT | CTC | 1056 |
| | Ser | Thr | Val | Gln | Thr | Trp | Phe | Lys | Pro | Leu | Ala | Tyr | Ala | Phe | Ile | Leu | |
| | | | | 340 | | | | | 345 | | | | | 350 | | | |
| 20 | ACA | AGG | GAA | TCT | GGA | TAC | OCT | CAG | GTT | TTC | TAC | GGG | GAT | ATG | TAC | GGG | 1104 |
| | Thr | Arg | Glu | Ser | Gly | Tyr | Pro | Gln | Val | Phe | Tyr | Gly | Asp | Met | Tyr | Gly | |
| | | 355 | | | | | 360 | | | | | 365 | | | | | |
| | ACG | AAA | GGA | GAC | TOC | CAG | CGC | GAA | ATT | OCT | GOC | TTG | AAA | CAC | AAA | ATT | 1152 |
| | Thr | Lys | Gly | Asp | Ser | Gln | Arg | Glu | Ile | Pro | Ala | Leu | Lys | His | Lys | Ile | |
| | | 370 | | | | | 375 | | | | | 380 | | | | | |
| | GAA | COG | ATC | TTA | AAA | GCG | AGA | AAA | CAG | TAT | GCG | TAC | GGA | GCA | CAG | CAT | 1200 |
| 30 | Glu | Pro | Ile | Leu | Lys | Ala | Arg | Lys | Gln | Tyr | Ala | Tyr | Gly | Ala | Gln | His | |
| | | 385 | | | | 390 | | | | | 395 | | | | 400 | | |
| | GAT | TAT | TTC | GAC | CAC | CAT | GAC | ATT | GTC | GGC | TGG | ACA | AGG | GAA | GGC | GAC | 1248 |
| | Asp | Tyr | Phe | Asp | His | His | Asp | Ile | Val | Gly | Trp | Thr | Arg | Glu | Gly | Asp | |
| 35 | | | | | 405 | | | | | 410 | | | | | 415 | | |
| | AGC | TOG | GTT | GCA | AAT | TCA | GGT | TTG | GCG | GCA | TTA | ATA | ACA | GAC | GGA | CCC | 1296 |
| | Ser | Ser | Val | Ala | Asn | Ser | Gly | Leu | Ala | Ala | Leu | Ile | Thr | Asp | Gly | Pro | |
| | | | | 420 | | | | | 425 | | | | | 430 | | | |
| 40 | GGT | GGG | GCA | AAG | CGA | ATG | TAT | GTC | GGC | CGG | CAA | AAC | GCC | GGT | GAG | ACA | 1344 |
| | Gly | Gly | Ala | Lys | Arg | Met | Tyr | Val | Gly | Arg | Gln | Asn | Ala | Gly | Glu | Thr | |
| | | | 435 | | | | | 440 | | | | | 445 | | | | |
| | TGG | CAT | GAC | ATT | AOC | GGA | AAC | OGT | TOG | GAG | COG | GTT | GTC | ATC | AAT | TOG | 1392 |
| | Trp | His | Asp | Ile | Thr | Gly | Asn | Arg | Ser | Glu | Pro | Val | Val | Ile | Asn | Ser | |
| | | 450 | | | | | 455 | | | | | 460 | | | | | |
| | GAA | GGC | TGG | GGA | GAG | TTT | CAC | GTA | AAC | GGC | GGG | TOG | GTT | TCA | ATT | TAT | 1440 |
| 50 | Glu | Gly | Trp | Gly | Glu | Phe | His | Val | Asn | Gly | Gly | Ser | Val | Ser | Ile | Tyr | |
| | | 465 | | | | 470 | | | | | 475 | | | | | 480 | |
| | GTT | CAA | AGA | COG | AAA | COG | TOC | AOC | COG | COG | GGG | TOC | TOG | CGA | ATG | AAA | 1488 |
| | Val | Gln | Arg | Pro | Lys | Pro | Ser | Thr | Pro | Pro | Gly | Ser | Ser | Arg | Met | Lys | |
| 55 | | | | | 485 | | | | | 490 | | | | | 495 | | |

61

CAG CTG GAA GAC AAA GTT GAA GAA CTG CTG TOC AAA AAC TAC CAC CTG 1536
 Gln Leu Glu Asp Lys Val Glu Glu Leu Leu Ser Lys Asn Tyr His Leu
 500 505 510
 5 GAA AAC GAA GTT GCT CGT CTG AAA AAG CTT GTT GGT GAA CGT GGG GGC 1584
 Glu Asn Glu Val Ala Arg Leu Lys Lys Leu Val Gly Glu Arg Gly Gly
 515 520 525
 TGT GGG GGC 1593
 10 Cys Gly Gly
 530

(2) INFORMATION FOR SEQ ID NO: 2:

15

(i) SEQUENCE CHARACTERISTICS:

(A) LENGTH: 531 amino acids

(B) TYPE: amino acid

(D) TOPOLOGY: linear

20

(ii) MOLECULE TYPE: protein

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 2:

25 Ala Asn Leu Asn Gly Thr Leu Met Gln Tyr Phe Glu Trp Tyr Met Pro
 1 5 10 15
 Asn Asp Gly Gln His Trp Arg Arg Leu Gln Asn Asp Ser Ala Tyr Leu
 20 25 30
 30 Ala Glu His Gly Ile Thr Ala Val Trp Ile Pro Pro Ala Tyr Lys Gly
 35 40 45
 Thr Ser Gln Ala Asp Val Gly Tyr Gly Ala Tyr Asp Leu Tyr Asp Leu
 35 50 55 60
 Gly Glu Phe His Gln Lys Gly Thr Val Arg Thr Lys Tyr Gly Thr Lys
 65 70 75 80
 40 Gly Glu Leu Gln Ser Ala Ile Lys Ser Leu His Ser Arg Asp Ile Asn
 85 90 95
 Val Tyr Gly Asp Val Val Ile Asn His Lys Gly Gly Ala Asp Ala Thr
 100 105 110
 45 Glu Asp Val Thr Ala Val Glu Val Asp Pro Ala Asp Arg Asn Arg Val
 115 120 125
 Ile Ser Gly Glu His Leu Ile Lys Ala Trp Thr His Phe His Phe Pro
 50 130 135 140
 Gly Arg Gly Ser Thr Tyr Ser Asp Phe Lys Trp His Trp Tyr His Phe
 145 150 155 160
 55 Asp Gly Thr Asp Trp Asp Glu Ser Arg Lys Leu Asn Arg Ile Tyr Lys
 165 170 175

62

Phe Gln Gly Lys Ala Trp Asp Trp Glu Val Ser Asn Glu Asn Gly Asn
 180 185 190

Tyr Asp Tyr Leu Met Tyr Ala Asp Ile Asp Tyr Asp His Pro Asp Val
 5 195 200 205

Ala Ala Glu Ile Lys Arg Trp Gly Thr Trp Tyr Ala Asn Glu Leu Gln
 210 215 220

10 Leu Asp Gly Phe Arg Leu Asp Ala Val Lys His Ile Lys Phe Ser Phe
 225 230 235 240

Leu Arg Asp Trp Val Asn His Val Arg Glu Lys Thr Gly Lys Glu Met
 245 250 255

15 Phe Thr Val Ala Glu Tyr Trp Gln Asn Asp Leu Gly Ala Leu Glu Asn
 260 265 270

Tyr Leu Asn Lys Thr Asn Phe Asn His Ser Val Phe Asp Val Pro Leu
 20 275 280 285

His Tyr Gln Phe His Ala Ala Ser Thr Gln Gly Gly Gly Tyr Asp Met
 290 295 300

25 Arg Lys Leu Leu Asn Gly Thr Val Val Ser Lys His Pro Leu Lys Ser
 305 310 315 320

Val Thr Phe Val Asp Asn His Asp Thr Gln Pro Gly Gln Ser Leu Glu
 325 330 335

30 Ser Thr Val Gln Thr Trp Phe Lys Pro Leu Ala Tyr Ala Phe Ile Leu
 340 345 350

Thr Arg Glu Ser Gly Tyr Pro Gln Val Phe Tyr Gly Asp Met Tyr Gly
 35 355 360 365

Thr Lys Gly Asp Ser Gln Arg Glu Ile Pro Ala Leu Lys His Lys Ile
 370 375 380

40 Glu Pro Ile Leu Lys Ala Arg Lys Gln Tyr Ala Tyr Gly Ala Gln His
 385 390 395 400

Asp Tyr Phe Asp His His Asp Ile Val Gly Trp Thr Arg Glu Gly Asp
 405 410 415

45 Ser Ser Val Ala Asn Ser Gly Leu Ala Ala Leu Ile Thr Asp Gly Pro
 420 425 430

Gly Gly Ala Lys Arg Met Tyr Val Gly Arg Gln Asn Ala Gly Glu Thr
 50 435 440 445

Trp His Asp Ile Thr Gly Asn Arg Ser Glu Pro Val Val Ile Asn Ser
 450 455 460

55 Glu Gly Trp Gly Glu Phe His Val Asn Gly Gly Ser Val Ser Ile Tyr
 465 470 475 480

63

Val Gln Arg Pro Lys Pro Ser Thr Pro Gly Ser Ser Arg Met Lys
485 490 495

5 Gln Leu Glu Asp Lys Val Glu Glu Leu Leu Ser Lys Asn Tyr His Leu
500 505 510

Glu Asn Glu Val Ala Arg Leu Lys Lys Leu Val Gly Glu Arg Gly Gly
515 520 525

10 Cys Gly Gly
530

(2) INFORMATION FOR SEQ ID NO: 3:

- 15 (i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 69 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

- 20 (ii) MOLECULE TYPE: synthetic DNA
(iv) ANTI-SENSE: YES

25 (xi) SEQUENCE DESCRIPTION: SEQ ID NO: 3:

CAGCCCCAC AGCCCCAAG TTCAACAACA AGCTTTTCA GACGAGCAAC TTGGTTTTCC 60
 AGGTGGTAG 69

(2) INFORMATION FOR SEQ ID NO: 4:

- 35 (i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 54 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

- 40 (ii) MOLECULE TYPE: synthetic DNA
(iv) ANTI-SENSE: YES

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 4:

45 TTTTGGACA GCAGTCTTC AACTTTGCTT TCCAGCTGT TCATTGOGA GGAC 54

(2) INFORMATION FOR SEQ ID NO: 5:

- 50 (i) SEQUENCE CHARACTERISTICS:
(A) LENGTH: 66 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
55 (D) TOPOLOGY: linear
- (ii) MOLECULE TYPE: synthetic DNA

64

(iv) ANTI-SENSE: NO

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 5:

5 CCGGGTCTC GCGAATGAAA CAGCTGGAAG ACAAGTGA AGAAGTCTG TCACAAAAC 60
ACCAAC 66

10 (2) INFORMATION FOR SEQ ID NO: 6:

(i) SEQUENCE CHARACTERISTICS:

15 (A) LENGTH: 65 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: synthetic DNA

20 (iv) ANTI-SENSE: NO

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 6:

25 TGGAAAAGA AGTGTCTGT CTGAAAAGC TTGTTGGTGA AGTGGGGGC TGTEGGGGCT 60
GAGCT 65

(2) INFORMATION FOR SEQ ID NO: 7:

30

(i) SEQUENCE CHARACTERISTICS:

35 (A) LENGTH: 90 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: synthetic DNA

(iv) ANTI-SENSE: YES

40

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 7:

CAATGGTGAT GAGGACCTTC GATGCCCCCA CAGCCCCAC GTTACCAAC AAGCTTTTTC 60
45 AGACGAGCAA CTTCGTTTTT CAGGTGGTAG 90

(2) INFORMATION FOR SEQ ID NO: 8:

50

(i) SEQUENCE CHARACTERISTICS:

55 (A) LENGTH: 86 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

(ii) MOLECULE TYPE: synthetic DNA

65

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 8:

TGGAAGACGA AGTTGCTGGT CTGAAAAGC TTGTTGGTGA ACGTGGGGGC TTGTTGGGGCA 60
5 TGAAGGTGG TCATCAACAT TGAGCT 86

(2) INFORMATION FOR SEQ ID NO: 9:

(i) SEQUENCE CHARACTERISTICS:
10 (A) LENGTH: 65 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

15 (ii) MOLECULE TYPE: primer

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 9:

CAGTCACAGA TCTGCGGAA TTGGGCGAGC CGGCGATGC CGCAATCTT AATGGGAGGC 60
20 TGATG 65

(2) INFORMATION FOR SEQ ID NO: 10:

(i) SEQUENCE CHARACTERISTICS:
25 (A) LENGTH: 63 base pairs
(B) TYPE: nucleic acid
(C) STRANDEDNESS: single
(D) TOPOLOGY: linear

30 (ii) MOLECULE TYPE: primer

(xi) SEQUENCE DESCRIPTION: SEQ ID NO: 10:

35 CATTGCGAG GACCGGGGG GGGTGAAGG TTGGGTCTT TGAACATAA TTGAACCGA 60
CCC 63

PATENT CLAIMS

1. A process for producing a polypeptide with reduced allergenicity, by
 - 5 a) fermenting a microorganism capable of producing said polypeptide, and
 - b) recovering said polypeptide in substantially pure form, wherein said microorganism is modified in a manner whereby the expressed polypeptide molecules self-oligomerize.
- 10 2. The process according to claim 1, wherein said microorganism is modified by the introduction of one or more DNA constructs comprising at least one DNA sequence coding for at least one polypeptide and at least one Zipper domain operably
15 linked to each other.
3. The process according to claim 2, wherein the Zipper domain is an α -helical bundle comprises from two, three, four, five, six or seven helices
- 20 4. The process according to claims 1 and 2, wherein the said Zipper domain is a Polar Zipper of poly(L-glutamine) repeats.
5. The process according to any of the claims 2 to 3, wherein
25 the Zipper domain comprises an amphiphilic helical bundle.
6. The process according to any of claims 2, 3 and 5, wherein the Zipper domain is a Leucine Zipper or a modification thereof.
- 30 7. The process according to claim 6, wherein the Zipper domain results in the formation of a hetero-dimer.
8. The process according to claim 7, wherein one Leucine
35 Zipper is a Fos Leucine Zipper and the other is a Jun Leucine Zipper.
9. The process according to any of the claims 6 to 8, wherein

a cysteine is included in the Leucine Zipper.

10. The process according to any of claims 2, 3 and 5, wherein the Zipper domain is an antiparallel four-helical bundle or a 5 modification thereof.

11. The process according to any of claims 1 to 10, wherein said DNA construct comprises an operably inserted linker sequence between the DNA sequence coding for said polypeptide and 10 the DNA sequence coding for said Zipper domain.

12. The process according to any of the claims 1 to 11, wherein the DNA sequence encodes an enzyme.

15 13. The process according to claim 12, wherein the DNA sequence encodes at least one enzyme selected from the group comprising proteases (metallo, acid, neutral or alkaline), lipases, cellulases, amylases, lyases, xylanases, pectinases, pullulanase, polygalacturonases, oxidases, laccases, oxidoreductases, trans- 20 glutaminases, α -galactosidases, phytases and peroxidases

14. The process according to any of claims 1 to 13, wherein the DNA sequence encodes polypeptides having a molecular weight of about 5 kDa to 150 kDa, preferably from 20 kDa to 100 kDa, 25 especially from 20 kDa to 80 kDa.

15. The process according to any of claims 1 to 14, wherein the enzyme is Termamyl®.

30 16. The process according to any of claims 1 to 15, wherein the oligomerization is a dimerization.

17. The process according to any of claims 1 to 15, wherein the oligomerization is a trimerization.

35

18. The process according to any of claims 1 to 15, wherein the oligomerization is an tetramerization.

19. The process according to claim 1 to 18, wherein the micro-organism is a bacterium, a yeast or a filamentous fungus.

20. The process according to claim 19, wherein said bacterium
5 is selected from the group comprising grampositive bacteria such as strains of *Bacillus*, such as strains of *B. subtilis*, *B. licheniformis*, *B. lentus*, *B. brevis*, *B. stearothermophilus*, *B. alkalophilus*, *B. amyloliquefaciens*, *B. coagulans*, *B. circulans*, *B. lautus*, *B. megaterium* or *B. thuringiensis*, or strains of
10 *Streptomyces*, such as *S. lividans*, *S. murinus* or *S. griseus*, or gramnegative bacteria such as *Escherichia coli*.

21. The process according to claim 20, wherein the host cell is *B. licheniformis* or *E. coli*.

15

22. The process according to claim 19, wherein said yeast is selected from the group comprising *Saccharomyces* spp. or *Schizosaccharomyces* spp., in particular strains of *Saccharomyces cerevisiae* or *Saccharomyces kluyveri*, or cells are strains of
20 *Kluyveromyces*, such as *K. lactis*, *Hansenula*, such as *H. polymorpha*, or *Pichia*, in particular *P. pastoris*.

23. The process according to claim 19, wherein said filamentous fungus is selected from the group comprising *Aspergillus* spp.,
25 *Neurospora* spp., *Fusarium* spp. or *Trichoderma* spp., in particular strains of *A. oryzae*, *A. nidulans* or *A. niger* or *F. oxysporum*.

24. A DNA construct for producing polypeptides with reduced
30 allergenicity comprising a DNA sequence encoding at least one polypeptide and at least one Zipper domain operably linked to each other.

25. The DNA construct according to claim 24, comprising a
35 linker sequence inserted operably between DNA coding for the parent polypeptide and DNA coding for said Zipper domain.

26. The DNA construct according to claims 24 and 25, comprising

a DNA sequence which when expressed exhibits at least one enzymatic activity.

27. The DNA construct according to claim 26, capable of
5 expressing an enzyme selected from the group comprising proteases (metallo, acid, neutral or alkaline), lipases, cellulases, amylases, lyases, xylanases, pectinases, polygalacturonases, oxidases, laccases, oxidoreductases, transglutaminases, α -galactosidases, phytases or peroxidases.

10

28. The DNA construct according to any of claims 24 to 27, wherein the DNA sequence encodes polypeptides with a molecular weight of about 5 kDa to 150 kDa, preferably from 20 kDa to 100 kDa, especially from 20 kDa to 80 kDa.

15

29. The DNA construct according to any of claims 24 to 28, wherein the enzyme is Termamyl®.

30. The DNA construct according to any of claim 24 to 29, comprising the DNA sequence shown in SEQ ID NO 1.

31. A recombinant vector or transformation vehicle, comprising a DNA construct according to any of claims 24 to 30.

25 32. The vector according to claim 31, wherein said DNA construct is operably linked to a secretion signal.

33. The vector according to claims 31 and 32, wherein said DNA construct comprise a sequence encoding an affinity tag.

30

34. The vector according to any of claims 31 to 33, wherein said vector is the pAZ-1 plasmid.

35. A cell comprising a DNA construct according to any of
35 claims 24 to 30 or a recombinant vector or expression vector according to any of claims 31 to 34.

36. The cell according to claim 35, wherein the cell is a

bacterium, a yeast or a filamentous fungus.

37. The cell according to claim 36, wherein said bacterium is selected from the group comprising grampositive bacteria such as strains of *Bacillus*, such as strains of *B. subtilis*, *B. licheniformis*, *B. lentus*, *B. brevis*, *B. stearothermophilus*, *B. alkalophilus*, *B. amyloliquefaciens*, *B. coagulans*, *B. circulans*, *B. lautus*, *B. megaterium* or *B. thuringiensis*, or strains of *Streptomyces*, such as *S. lividans*, *S. murinus* or *S. griseus*, or gramnegative bacteria such as *Escherichia coli*.

38. The cell according to claim 37, wherein the cell is *B. licheniformis* or *E. coli*.

39. The cell according to claim 36, wherein said yeast cell is selected from the group comprising *Saccharomyces* spp. or *Schizosaccharomyces* spp., in particular strains of *Saccharomyces cerevisiae* or *Saccharomyces kluyveri*, or cells are strains of *Kluyveromyces*, such as *K. lactis*, *Hansenula*, such as *H. polymorpha*, or *Pichia*, in particular *P. pastoris*.

40. The cell according to claim 36, wherein the filamentous fungus is selected from the group comprising *Aspergillus* spp., *Neurospora* spp., *Fusarium* spp. or *Trichoderma* spp., in particular strains of *A. oryzae*, *A. nidulans* or *A. niger* or *F. oxysporum*.

41. A microbially produced polypeptide with reduced allergenicity produced according to any of claims 1 to 23.

30

42. The polypeptide according to claim 41, comprising from 2 to 10 polypeptide molecules.

43. The polypeptide according to claim 42 is a dimer.

35

44. The polypeptide according to claim 42 is a trimer.

45. The polypeptide according to claim 42 is a tetramer.

46. The polypeptide according to any of claims 41 to 45, exhibiting enzymatic activity.

47. The polypeptide according to claim 46, exhibiting at least one enzyme activity exhibited by enzymes selected from the group comprising proteases (metallo, acid, neutral or alkaline), lipases, cellulases, amylases, lyases, xylanases, pectinases, pullulanase, polygalacturonases, oxidases, laccases, oxidoreductases, transglutaminases, α -galactosidases, phytases and peroxidases

48. The polypeptide according to any of claims 41 to 47, wherein the monomeric polypeptide molecule has a molecular weight of about 5 kDa to 150 kDa, preferably from 20 kDa to 100 kDa, especially from 20 kDa to 80 kDa.

49. The polypeptide according to any of claims 41 to 48, wherein the enzyme exhibits α -amylase activity.

50. An oligomeric polypeptide with reduced allergenicity comprising at least one polypeptide bonded or linked to at least one Zipper domain which is coupled to at least one polypeptide bonded or linked to at least one Zipper domain.

51. The oligomeric polypeptide according to claim 50, wherein the Zipper domain comprises an α -helical bundle.

52. The oligomeric polypeptide according to claim 51, wherein the said α -helical bundle comprises two, three, four, five, six or seven helices.

53. The oligomeric polypeptide according to any of the claims 50 to 52, wherein the Zipper domain comprises an amphiphilic helical bundle.

54. The oligomeric polypeptide according to claim 50, wherein the Zipper domain is a Polar Zipper of poly(L-glutamine) repeats or modifications thereof.

55. The oligomeric polypeptide according to any of claims 50 to 53, wherein the Zipper domain is a Leucine Zipper or a modification thereof.

5

56. The oligomeric polypeptide according to claims 54 and 55, wherein the Zipper domain oligomerization results in the formation of a hetero-dimer.

10 57. The oligomeric polypeptide according to claim 56, wherein one Leucine Zipper is a Fos Leucine Zipper and the other is a Jun Leucine Zipper.

58. The oligomeric polypeptide according to any of the claims 15 55 to 57, wherein a cysteine is included in the Leucine Zipper.

59. The oligomeric polypeptide according to any of claims 50 to 58, wherein the Zipper domain is an antiparallel four-helical bundle or a modification thereof.

20

60. The oligomeric polypeptide according to any of claims 50 to 59, wherein said DNA construct comprises an operably inserted linker sequence between the DNA sequence coding for said polypeptide and the DNA sequence coding for said Zipper domain.

25

61. The oligomeric polypeptide according to any of claims 50 to 60 wherein said polypeptide exhibits enzymatic activity.

62. The oligomeric polypeptide according to claims 61, wherein 30 the polypeptide exhibits at least one enzyme activity exhibited by enzymes selected from the group comprising proteases (metallo, acidic, neutral or alkaline), lipases, cellulases, amylases, lyases, xylanases, pectinases, pullulanase, polygalacturonases, oxidases, laccases, oxidoreductases, transglutaminases, 35 α -galactosidases, phytases and peroxidases

63. The oligomeric polypeptide according to any of claims 61 to 62, wherein the monomeric polypeptide molecule has a molecular

weight of about 5 kDa to 150 kDa, preferably from 20 kDa to 100 kDa, especially from 20 kDa to 80 kDa.

64. The oligomeric polypeptide according to any of claims 61 to 5 63, wherein the enzyme exhibits α -amylase activity.

65. The oligomeric polypeptide according to any of claims 50 to 59, wherein said Zipper domain is linked to said polypeptide and the C-terminal of the polypeptide.

10

66. The oligomeric polypeptide according to any of claims 50 to 59, wherein said Zipper domain is linked to said polypeptide and the N-terminal of the polypeptide.

15 67. A composition comprising at least one polypeptide according to any of the claims 41 to 49 and/or at least one oligomeric polypeptides according to any of claims 50 to 66.

68. The composition according to claim 67, comprising ingredi-
20 ents normally used in detergents, household articles, agrochemicals, personal care products, cosmetics, toiletry, pharmaceuticals, composition use for treating textiles, food and/or feed.

25 69. Use of Zipper domains for reducing allergenicity of polypeptides.

70. The use according to claim 69, wherein said Zipper domains are used for oligomerizing polypeptide molecules.

30

71. The use according to claims 69 and 70, for a process according to any of claims 1 to 23 or in oligomeric polypeptides according to any of claims 50 to 66.

35 72. The use according to any of claims 69 to 71, wherein the Zipper domain comprises two, three, four, five, six or seven α -helical bundles.

73. The use according to any of claims 69 to 71, wherein the said Zipper domain is a Polar Zipper of poly(L-glutamine) repeats or a modification thereof.

5 74. The use according to any of the claims 71 and 72, wherein said Zipper domain comprises an amphipathic helical bundle.

75. The use according to any of claims 71, 72 and 74, wherein said Zipper domain is a Leucine Zipper or a modification thereof.
10 of.

76. The use according to claim 75, wherein the Leucine Zipper is a Fos-Jun Leucine Zipper.

15 77. The use according to any of the claims 75 and 76, wherein a cysteine is included in the Leucine Zipper.

78. The use according to any of claims 71, 72 and 74, wherein said Zipper domain is an antiparallel four-helical bundle or a
20 modification thereof.

79. The use according to any of claims 69 to 78, in household articles.

25 80. The use according to any of claims 69 to 78, in detergents, including dishwashing detergents and soap bars.

81. The use according to any of claims 69 to 78, in personal care products.

30

82. The use according to claim 81, in oral care products including cleaning products for dentures and dentifrices.

83. The use according to claim 81, in skin care products including
35 creams and lotions.

84. The use according to claim 81, in hair care or hair treatment products, including shampoos.

85. The use according to claim 81, in contact lens cleaning products.

86. The use according to any of claims 69 to 78, in cosmetics.

5

87. The use according to any of claims 69 to 78, in pharmaceuticals.

88. The use according to any of claims 69 to 78, in agrochemicals.

89. The use according to any of claims 69 to 78, in food and feed.

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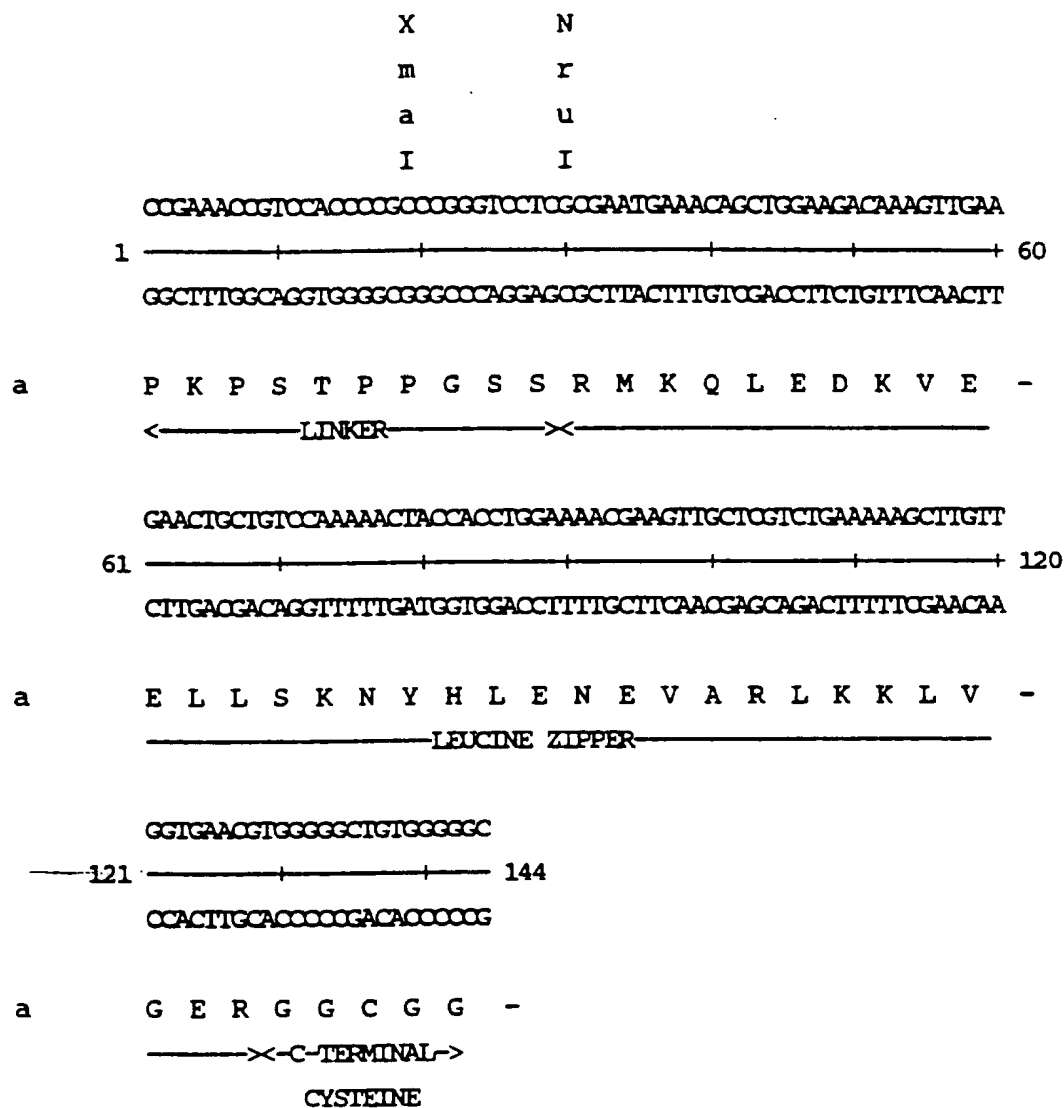
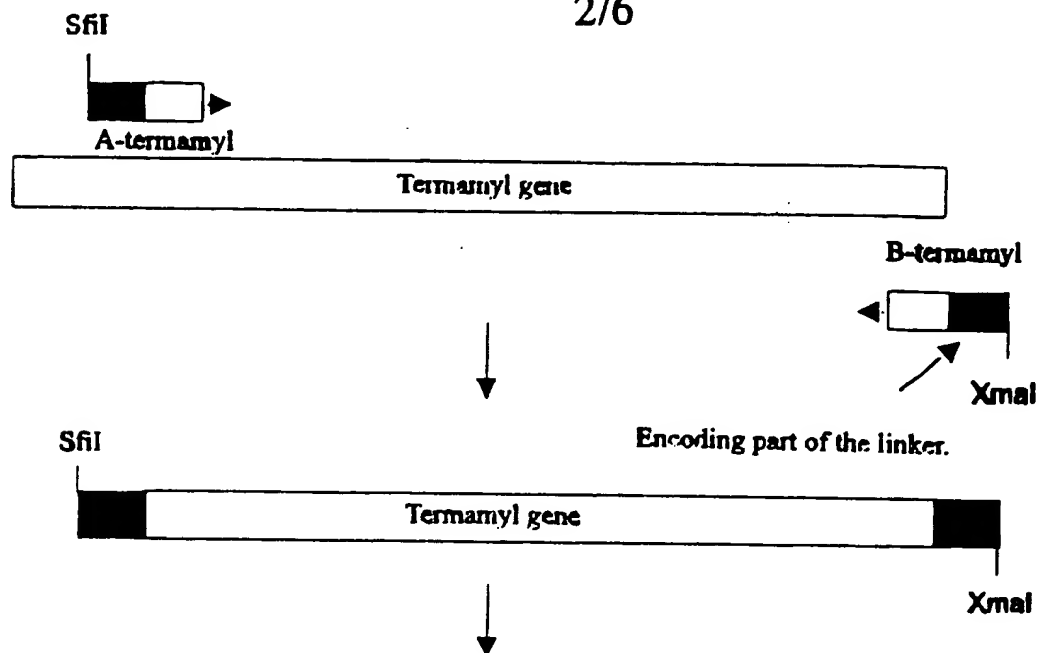


Figure 1

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SfiI-XmaI digested fragment is inserted into SfiI-XmaI digested pFab3.

Linker encoding Leucine Zipper GCN4 is inserted through XmaI and SacI sites.

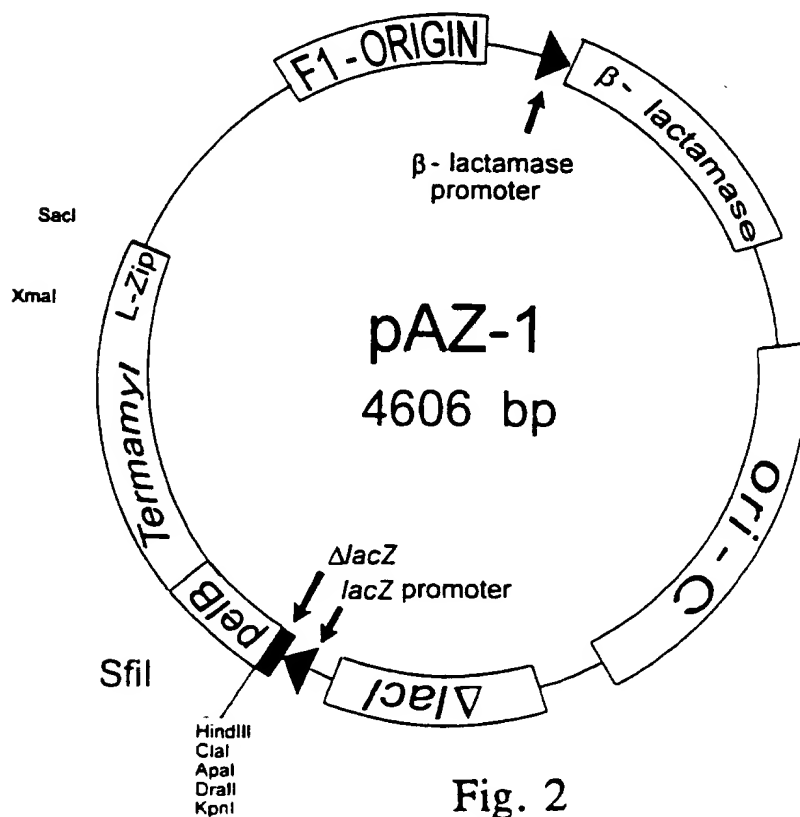


Fig. 2

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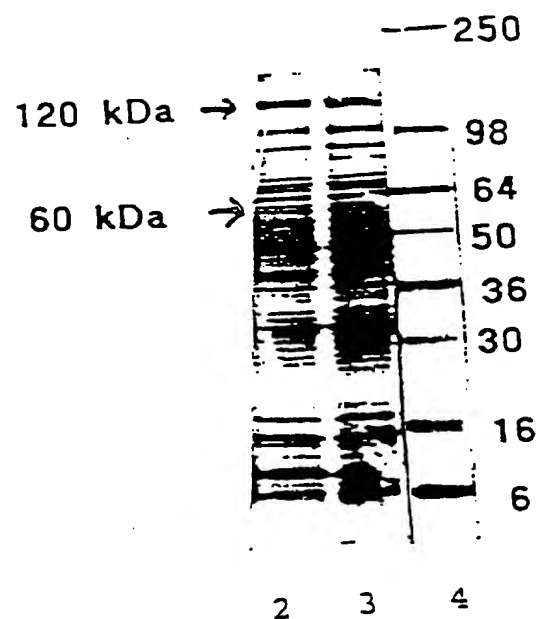


Figure 3

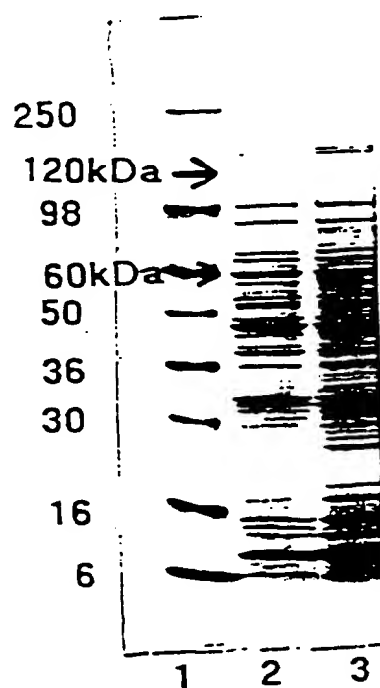


Figure 4

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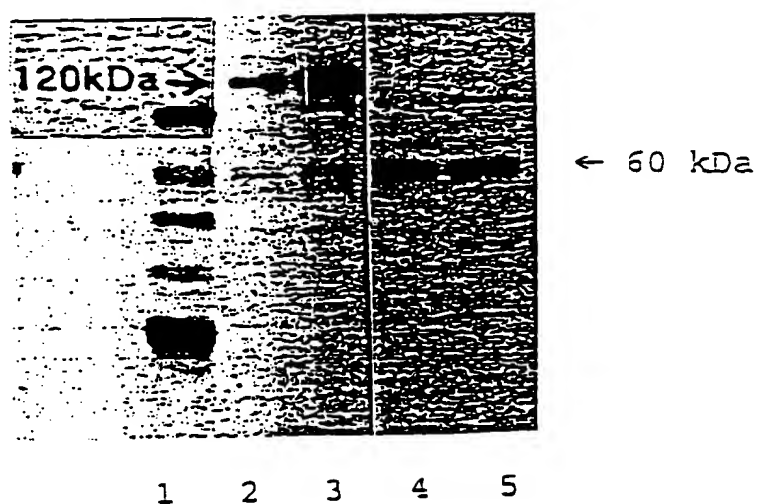


Figure 5

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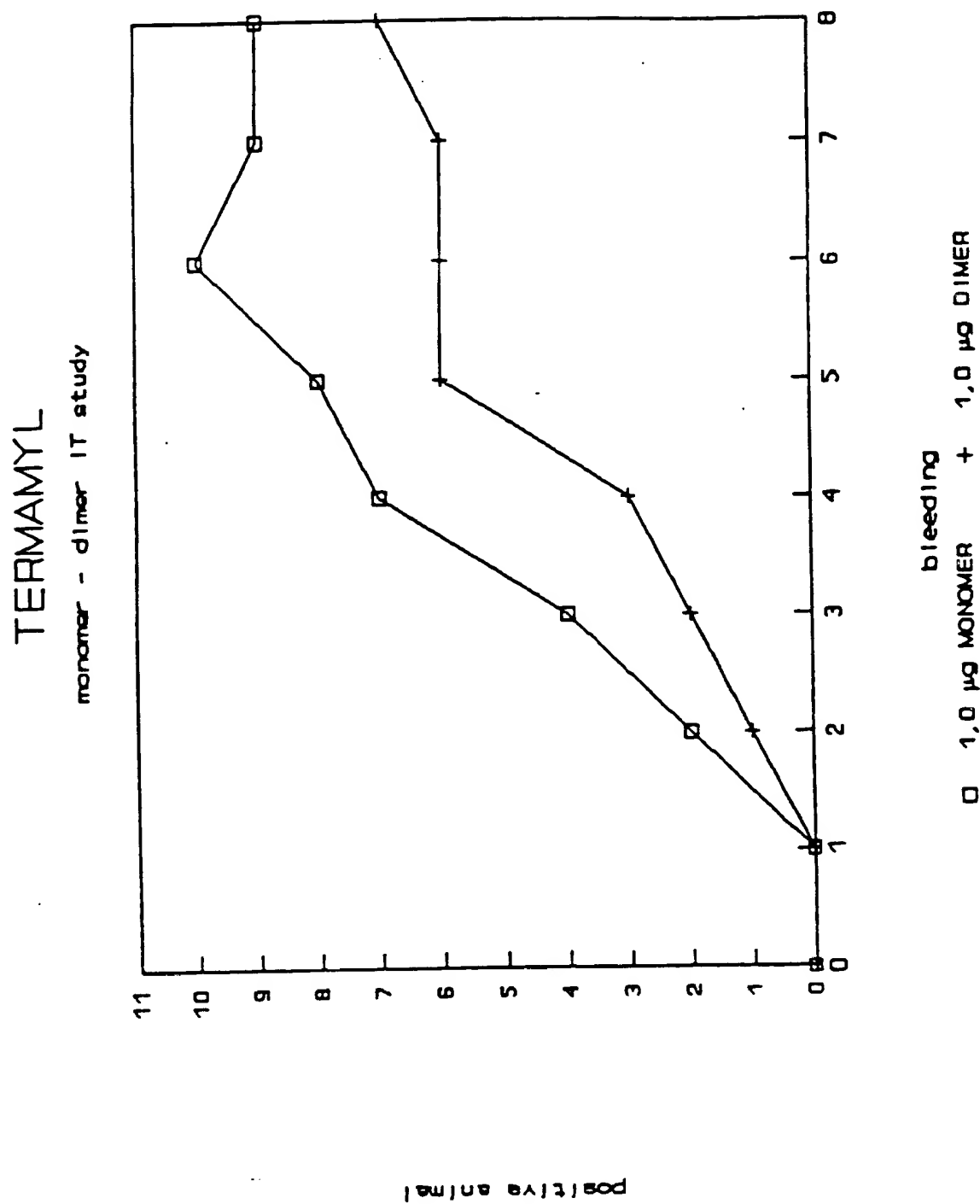


Fig. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK 95/00463

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: C12N 15/62, C12N 9/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: C12N, C07K, C12P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

MEDLINE, BIOSIS, EMBASE, WPI, WPIL, US PATENTS FULLTEXT DATABASES,
SCISEARCH

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|---|-----------------------|
| X | WO 9410308 A1 (IMMUNEX CORPORATION), 11 May 1994 (11.05.94), page 2, line 22 - line 24, the claims | 1-68 |
| Y | -- | 69-89 |
| A | WO 9410191 A1 (NOVO NORDISK A/S), 11 May 1994 (11.05.94), page 3, line 33 - line 36; page 4, line 1 - line 8; page 4, line 26 - line 36, the claims and the abstract | 1-68 |
| Y | -- ----- | 69-89 |

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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O document referring to an oral disclosure, use, exhibition or other means

P document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

& document member of the same patent family

Date of the actual completion of the international search

21 March 1996

Date of mailing of the international search report

26 -03- 1996

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INTERNATIONAL SEARCH REPORT
Information on patent family members

05/02/96

International application No.
PCT/DK 95/00463

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---------------------|----------------------------|---------------------|
| WO-A1- 9410308 | 11/05/94 | NONE | |
| WO-A1- 9410191 | 11/05/94 | NONE | |

